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INDIAN MUSEUM

Vol. XVIII.

REPORT ON THE

AQUATIC FAUNA OF SEISTAN

WITH SUBSIDIARY STUDIES.

Part I.

September, 1919.

	PAGE
Geographical Introduction ..	3
The Mollusca of the Inland Waters of Baluchistan and of Seistan, with a note on the Liver-Fluke of Sheep in Seistan..	17
Notes on Fish of the genus *Discognathus* from India and Persia ..	65
Notes on Odonata collected in Seistan and Baluchistan in winter ..	79

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CONTENTS

PART I. *Published 11th September*, 1919.

Page

Geographical Introduction. (*N. Annandale.*) 3

The Molluscs of the Inland Waters of Baluchistan and of Seistan, with a note on the Liver-fluke of Sheep in Seistan. (*N. Annandale, B. Prashad* and *S. W Kemp.*) 17

Notes on Fish of the genus *Discognathus* from India and Persia. (*N. Annandale.*) 65

Notes on Odonata collected in Seistan and Baluchistan in winter. (*F. C. Fraser.*) 79

PART II. *Published 20th December*, 1919.

Sponges, Hydrozoa and Polyzoa of Seistan. (*N. Annandale*) 83

Carabidae from Seistan. (*H. E. Andrewes.*) 99

Report on the Fresh-water Gastropod Molluscs of Lower Mesopotamia. Part I.—The genus *Limnaea*. (*N. Annandale* and *B. Prashad.*) 103

On a new genus and species of Coccidae from North-Western India and Eastern Persia. (*E. E. Green.*) 117

Notes on two collections of Birds from Seistan. (*E. C. Stuart Baker.*) 121

PART III. *Published 29th April*, 1920.

Note on the occurrence of the Leech *Limnatis nilotica* in Seistan and the Afghan-Baluch Desert. (*N. Annandale* and *Amin-ud-Din.*) 135

Notes on some Asiatic species of *Palingenia* [Order Ephemeroptera]. (*F H. Gravely.*) 137

List of Entomostraca collected in Seistan and the Baluch Desert. (*R. Gurney.*) 145

Report on the Fresh-water Gastropod Molluscs of Lower Mesopotamia. Part II.—The Family Planorbidae. (*N. Annandale.*) 147

PART IV *Published 15th September*, 1920.

The Fish of Seistan. (*N. Annandale* and *Sunder Lal Hora.*) 151

The Rhynchota-Heteroptera (Notonectidae and Corixidae) of Seistan. (*W. L. Distant.*) . 205

The Gross Anatomy of *Corbicula fluminalis*. (*B. Prashad.*) 209

Page

PART V *Published 29th April, 1921.*

Note on the Leech *Limnatis nilotica*. (*Tokio Kaburaki*.) 213

Report on the Fresh-water Gastropod Molluscs of Lower Mesopotamia. Part III.—The Families Neritidae, Hydrobiidae and Melaniidae. (*B. Prashad.*) 215

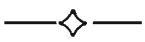
Notes on Larval Trematodes from Seistan. (*S. Kemp.*) 229

The Aquatic Fauna of Seistan: A Summary. (*N. Annandale.*) 235

LIST OF PLATES.

	Follow page
Plate I (Map of Seistan and the neighbouring country) Plate II (Cliff on the Western shore of the Hamun-i-Helmand, near Lab-i-Baring	16
Plates III—VIII (Mollusca)	64
Plates IX—XI (Fish)	78
Plate XII (Polyzoa)	98
Plates XIII—XIV (Mollusca)	116
Plates XV—XVI (Fish) Plate XVII (Shaped Rafts from India and Seistan)	204
Plates XVIII—XX (*Palingenia*)	144
Plates XXI—XXII (Coccidae)	120

ERRATA.



In the twenty-first line from top of page 45 for "are neither swollen" read "are neither greatly swollen."

In the twenty-fourth line from bottom of page 59 for "*L. jenkinsonianus*" read "*L. jenkinsianus.*"

In the twenty-third line from bottom of page 81 for "rice-beds" read "reed-beds."

INDEX.

[*N.B.*—An asterisk (*) preceding a line denotes a new variety or subspecies; a dagger (†) indicates a new species; a double dagger (‡) a new genus; synonyms are printed in italics.]

A

Page

Achtea bimaculata . 243
‡Adiposia 152, 155, 157, 182, 185, 186, 247
  longicauda 188
  macmahoni 151, 153, 154, 157, 187, 190, 191, 239, 240, 249
  maadinaea 151, 154, 157, 189, 239, 249
Aedon familiaris 123
Aegialitis dubia . 129
  dubia jerdoni .. 129
Aeschninae 79
Afrindella 91
Agrioninae .. 80
Agrobates galactodes familiaris 123
Alaemon alaudipes pallida 125
  desertorum 125
Alcyonella 94
‡Alocinma 23, 221, 223
Alveolina .. 12
  sphaeroidea 12
Amblyceps .. 184
Amnicola .. 23, 24, 25, 27, 221, 223
  orcula 23
  parvula .. 17, 18, 27
  (Alocinma) alticola 24
  ejecta 223
  orcula .. 27
  †sistanica 17, 19, 21, 24, 26, 249
Ammomanes deserti iranica . 125
  phoenicura zarudnyi 126
  phoenicuroides 125
Anagenesia 138, 140
Anisops fieberi . 205, 237, 251
Apiostoma zarudnyi 170
Ardea cinerea .. 132
Ardetta minuta 132
Argya caudata . 122
  caudata huttoni 122
Arthropoda .. 238
Athene bactriana .. 126
  noctua bactriana 126
Australella 93

B

Balitora 164
  maculata 164
Bembidium 99
  latiplaga 100
  niloticum 100
  varium 100
Bithinella .. 221, 222
Bithinella miliacea 222
  palmyrae 222
Bithynia 23, 221, 222, 223
  badiella .222, 223
  orcula 24
  orcula parvula 27
  rubens .. 223
  tentaculata . 246
Bosmina longirostris ..145, 252
Botaurus stellaris 132
Brachinus 101
Bubo bengalensis .. 126
  bubo bengalensis .. 126
  bubo turcomanus 126
Buccinum scabrum. 37
Bufo viridis .. .244, 249
Bullininae 148
Bullinus 147, 148, 246
  contortus 149, 215
  contortus approximaus .. 149
  dybowskii 149
Buteo ferox 126
Bythinella 221
Bythinia ejecta ..223, 224

C

Caprimulgus mahrattensis 126
Carabidae 99
Caridea 244
Cercaria .. 229, 231, 232
Ceriodaphnia pulchella 145, 252
  reticulata 145, 146, 252
Characeae 6, 9, 79, 242
Chironomus 242
  pictulus .. 250
Chlaenius semicyaneus 100
  spoliatus 100
Chaetogaster 23
  bengalensis 28, 241, 252
  punjabensis 238, 253
Chelonia 244
Chettusia leucura 129
Chondrostoma 164
Circus aeruginosus 127
  macrurus 127
Cirrhina 09, 162—167
  afghana .. 162
  latia 67
Cladocera 237
Clangula glaucion 134
Cobitidae 151, 152, 154—157, 178, 182, 188, 247
Coccidae 116

	Page
Columba eversmanni	127
intermedia	127
livia intermedia	127
Copepoda	237
Coracias garrula semenowi	121, 126
Corbicula	8, 21, 57, 209. 211,
cor	58, 236
crassula	58
fluminalis	18—21, 57, 58, 189, 209, 211, 235, 237—241, 250
fluminalis cor	58
lagillierti	209, 211
Corbitis stoliczkae	178
Corixa affinis	205, 237, 240, 251
hieroglyphica	205, 240, 251
ragenhoferi	206
†randana	206, 240, 251
†seistanensis	206, 251
substriata	206, 251
Corixidae	205, 236, 237
Corvus cornix	122
cornix sharpii	121, 122
frugilegus	122
frugilegus tschusii	121, 122
Coturnix communis	128
coturnix	128
Crossochilus	67, 69, 162, 163
Crustacea	145, 236, 240
Culex fatigans.	251
Cursorius gallicus	129
Cyclops leuckarti	145, 237, 252
strenuus	145, 237, 252
viridis	145, 252
Cygnus cygnus	132
musicus	132
Cyperus alterifolius	196
Cypridopsis dentatomarginatus	146
Cyprinidae	151, 153, 154, 156, 157
Cyprininae	151, 152, 155, 156, 157, 168
Cyprinion kirmanensis	159
Cyprinodontidae	152
Cyprinoidea	156, 186
Cyprinotus incongruens	146, 236
Cyprinus	164
godiyari	77
gotyla	75
lamta	77, 78, 164
(Garra) lamta	164
Cyrena cor	58
crassula	58
Cyrenidae	18, 57

D

	Page
Dafila acuta	133
acuta acuta	133
Daphnia longispina rosea	145, 252
magna	145, 146, 237, 252
Diaphanosoma brachyurum	146
Diaptomus salinus	146
Diplocheila transcaspica	100
Diptera	239
Discognathus	65-67, 69, 78, 156, 158, 161, 162, 164—166, 245
†adiscus	66, 68, 69, 71, 151, 152, 154, 156, 162, 163, 165—167, 238, 240—42, 249
Discognathus bicornutus	65, 66
ceylonensis	77
† elegans	66, 76, 77
gotyla	66, 72, 75
gravelyi	66, 67
imberbis	66
jerdoni	66, 73—77
jerdoni kangrae	72, 74
kangrae	74
lamta	65, 66, 71, 72, 74, 78, 158
macrochir	67, 78
nasutus	67, 78
persicus	72
†phryne	6—70, 151,—154, 156, 164, 166, 238, 239, 249
platycephalus	65, 66, 77
quadrimaculatus	67, 69
rufus	158
stenorhynchus	66, 74, 76
variabilis	67, 69—71, 154, 161, 164, 166, 167
vinciguerrae	67
wanae	65, 66, 69
Distichus planus	99
Dostia	215
Dyschirius	99
Dytiscidae	237

E

	Page
Entomostraca	145, 237, 238, 242
Ephemera	138
vulgata	141, 142
Ephemeroptera	137
Ephydatia fluviatilis	83, 84, 87, 90, 96, 242, 243, 247, 253,
fluviatilis himalayensis	83, 87
fluviatilis intha	83
fluviatilis syriaca	83, 87, 90
meyeni	247
mulleri	90
multiformis	90
Ephydridae	239
Erium	117
Eucypris clavata	145, 237, 252
pubera	146

F

	Page
Falco aesalon insignis	121, 127
Fasciola	22, 51, 62, 63
aegyptiaca	63
augusta	63
gigantea	23, 62, 63, 253
hepatica	51, 62, 229, 231
Francolinus francolinus henricii	128
vulgaris	128
Fredericella sultana	96, 242
sultana jordanica	83, 91, 242, 243, 247, 253
Fulica atra atra	128

G

	Page
Galatea	215
Gabrida cristata chendoola	121
cristata magna	125

Page

Gallinula chloropus parvifrons 121, 128
Gammarus 243
Garra 158, 161, 162, 164 165 245
crenulata 73
gotyla . 75
jerdoni .. 73
lamta 73
nasutus 162, 163, 165
obtusa .. 73
persica 65, 72
rufa . .. 73
(*Garra*) *ceylonensis* 77
Gastropoda 17, 23
Gerris 239, 243
Glaucion .. 134
Glaucionetta clangula 134
Glycia ornata 101
Glyptosternum 185, 186
Goniorhynchus 164
gotyla 73
stenorhynchus 74
Grus grus 130
Gyraulus 20, 52, 56, 147, 246,
albus 53, 57
convexiusculus 18, 19, 21—23, 40, 52—57, 147, 148, 215, 231, 232, 237, 238, 240, 242, 246, 250
devians euphratica .. 55
euphraticus 18—22, 40, 52—55, 147, 148, 215, 235, 237, 238, 240, 242, 246, 250
intermixtus .. 147, 148, 215
saigonensis 52, 55
velifer .. 56

H

Halmopota viridescens 239, 244, 251
Hemianax .. 79
ephippiger .. 79
Herpetocypris reptans 145, 252
Himantopus candidus 129
himantopus .. 129
Hirudinea 236
Hyalinella 93, 94
Hydra vulgaris 83, 90, 247, 253
Hydrobia .. 221
Hydrobiidae .. 17, 23, 215, 221
Hydrocena 27
Hydrometridae 239
Hydrophilidae 237
Hydroprogne caspia 131
Hydrozoa .. 83, 90

I

Ilyocypris bradyi 145, 146, 236, 237, 252
Insecta 236, 240
Ischnura 80, 81
elegans 80, 242, 250
senegalensis 80
Isidora brocchii 149
Ixobrychus minutus 132

L

Labeo rohita 169
Lamellibranchia 18, 57

Page

Lamellidens 8, 12, 21, 59
jenkinsonianus 59
marginalis 19, 20, 21, 57, 59, 239
marginalis candaharica 60
marginalis corrianus 59
*marginalis rhadinaeus 18, 19, 59, 60, 62, 160, 189, 239, 240, 242, 247, 250
Lanius cristatus isabellinus 123
cristatus phoenicuroides 123
phoenicuroides .. 123
Larus argentatus cachinnans 131
gelastes 131
ichthyaetus .. 131
ridibundus 131
Leptestheria tenuis 145, 238, 252
Libellulinae 79
Limnaea 19, 20, 22, 39, 41, 42, 45, 49, 103, 104, 246
auricularia 39, 41, 43, 104, 113
auricularia persica 41
bactriana 18, 19, 22, 39, 40—42, 44, 45, 48, 49, 104, 106, 107, 114, 231, 237, 238, 246, 250
canalifera 108
chlamys . 47, 246
†cor 104, 106, 111, 113
euphratica 113
†gedrosiana 18, 19, 21, 22, 39, 41, 42, 48—50, 63, 104, 106, 107, 110, 114, 239, 241, 242, 246, 250
*gedrosiana rectilabrum 18, 19, 22, 23, 40, 41, 42, 49, 106, 241 250
hordeum 18—21, 39, 41, 51, 106, 114, 246, 250
intermedia 45
†iranica 18, 19, 39, 41, 42, 43, 49, 106
lagotis 45, 47, 113
lagotis persica .. 43
lagotis subdisjuncta 47
ovata inflata 111
peregra .. 48, 49
peregra canalifera 104, 106, 108, 113, 215
peregra ovata .. 45
peregriformis 108, 111
persica 18—20, 39, 41, 106
stagnalis 20, 246
subpersica 41, 107
tenera 113, 114
tenera angustior . 114
tenera euphratica 104, 106, 113, 114, 215
truncatula 18, 19, 39, 41, 50, 51, 104, 106, 115
truncatula longula 51
Limnaeae 21, 39
Limnaeidae . 18, 21, 39, 47
Limnaeus lagotis persica .. 41
Limnatis nilotica 135, 136, 213, 214, 236, 247, 253
Limnatis (Poecilobdella) granulosa 136, 214
Limnicythere inopinata 140
Limosa belgica 129
limosa 126

Page

Lithoglyphus 221
Lophopodella 96, 241
capensis 96
capensis michaelseni 96
carteri 83, 91, 96, 238, 239, 247, 253
carteri davenporti 96, 247
carteri himalayana 97
stuhlmanni 96
thomasi 96

M

Machetes pugnax .. 130
Macrocorisa geffroyi 205, 237, 251
Marmaronetta augustirostris .. 133
Melania .. 28, 33, 222
adspersa 31, 33
elegans 28, 33, 37
pyramis 28, 32
pyramis adspersa 33
scabra elegans 37
tigrina 36
tuberculata 31, 224
tuberculata luteomarginata 35
(*Plotia*) *scabra elegans* .. 33
(*Striatella*) *tuberculata* 33
(*Striatella*) *tuberculata flavida* 34
Melaniidae 17, 21, 28—30, 215, 224
Melanoides 21, 28, 30, 224
elegans 29
fasciolata 31
pyramis 17, 18, 29, 32, 34—37 235
pyramis flavida 17, 19, 20, 22, 29, 30, 34—36, 225, 229, 235, 244
*pyramis leopardina 30, 33, 36
pyramis luteomarginata 17, 19, 29, 30, 34, 35
*pyramis puteicola 33, 34
scabra 19, 29, 34, 37
scabra elegans 18, 29, 32, 37
tigrina 18, 29, 30, 36
tuberculata 29, 31, 32 35—37, 149, 224
Melanopsis 20, 37, 225, 246
costata 225, 226
†deserticola 18, 19, 29, 30, 37
nodosa 225
praerosa nana .. 39
subtingitana 226
subtingitana laevis 226
turcica 225
turcica bellio .. 226
Merops persicus persicus 126
Metabletus fuscomaculatus 101
Microlestes corticalis 101
Micronecta biskrensis 206, 236, 251
†desertana 206, 236, 251
Microvelia 243
Mollusca 17, 235, 238, 240
Monticola solitaria pandoo 124
Motacilla alba personata 125
personata 125

N

‡Naiacoccus 117
†serpentinus 117
*serpentinus minor 118

Page

Naias major .. 9, 50, 242
Nais communis punjabensis 97, 238, 253
Nemachilus 155, 157, 178 185, 186
evezardi 185
lhasae 178—180
longicauda .. 155, 182
macmahoni 183, 187
montanus 167
rhadinaeus 183, 189
sargadensis 190
savona 185
stenurus .. 178—180
stoliczkae 151, 154, 157, 178, 179, 180, 239, 246, 249
stoliczkae leptosoma 179—181
stoliczkae productus 179, 180
yarkandensis 178
Neomelanien 28
Nerita tuberculata 31
Neritaea 216
macrii michoni 217
Neritidae 215
Neritina .. 215, 216
anatolica bellardii 217
anatolica mesopotamica 217
bellardii 217
crepidularia .. 216
crepidularia schlaefiii 216
depressa 216
jordani 216—220
jordani turris 218—220
meridionalis mesopotamica 217
mesopotamica 217
michoni 217
schlaefiii .. 216
(*Mitrula*) *schlaefiii* 216
(*Theodoxia*) *jordani* 218
(*Theodoxia*) *jordani aberrans* 218—220
(*Theodoxia*) *michoni* 218
Netta rufina 134
Nettium crecca 133
Notonecta 205
glauca 205, 237, 251
glauca marmorea 205
Notonectidae 205, 237
Notonectinae 205
Nummulites atacicus 11
Nyroca ferina 134

O

Odonata 79
Oenanthe alboniger 124
deserti atrogularis 124
isabellina 124
picata 124
Oligochaeta 238
Orthetrum 79
taeniolatum 79
Ostracoda 237

P

Palingenia 6, 137, 139, 189
longicauda 138, 139, 141, 142, 240, 250

	Page
Falingenia minor	143
robusta ..	138–140
(*Anagenesia*) *greeni* ..	141
(Anagenesia) lata	140
(Anagenesia) minor	143
†(Anagenesia) picta	140
(Anagenesia) robusta	140
Paludestrinidae ..	23
Paludina ..	27, 221, 222
badiella ..	27
parvula	27
Paludinella	221
Paludomus . ..	222
Passer moabiticus yatti	121, 125
montanus ..	124
montanus dilutus ..	124
Pectinatella davenporti	97
Pectinibranchia . ..	17
Pelecanus onocrotalus	131
onocrotalus onocrotalus	131
Phalacrocorax carbo	132
carbo subcormoranus	132
Phoenicopterus minor ..	132
Phoeincurus erythronotus ..	124
Phragmites	8, 26, 49
communis	8, 194, 241
kharka	8
Physa tiberidensis	149
(Isidora) Brochii ..	149
(Isodora) lirata ..	149
Physopsis ..	147
Pisidium paludosum	18, 19, 57
Planorbidae	18, 21, 52, 55, 147
anorbinae ..	147
anorbis	147
calathus	52, 56
compressus	52, 53, 54, 55
convexiusculus ..	52—54
euphraticus ..	52
nitidus	56
saigonensis ..	53—55
vortex	54
Planorbis (*Gyraulus*) *devians euphratica*	54, 148
(*Gyraulus*) *intermixtus* ..	148
Platycara ..	71, 164
nasutus	164
Plotia .	28, 30, 34
Plumatella ..	91
bigemmis	94, 242, 247
indica	94
jheringi ..	94
lendenfeldi	94
longigemmis ..	94
persica ..	92, 247
philippinensis	92
punctata ..	83, 94
tanganyikae	92
testudinicola . ..	83, 92
†(Afrindella) persica	83, 92, 240, 253
(Afrindella) tanganyikae ..	91
†(Hyalinella) bigemmis	83, 94, 253
Plumatellidae ..	91
Podiceps albipennis	134
cristatus ..	134
fluviatilis albipennis ..	134
Poecilobdella	..136, 214
Pogonus micans	99
Polyzoa	14, 83, 91, 239, 240, 242
Porifera	84
Porzana parva ..	128
porzana .. .	128
Potamocypris villosa	145, 146, 237, 252
Potamogeton	6, 7, 10, 47, 50, 238, 240, 241
lucens	9, 241
pectinatus	9, 49, 50, 145, 242
perfoliatus	.. 9, 242
Potamon gedrosianum	240, 251
(Potamon) potamios gedrosianum	145, 189
Prinia gracilis lepida	123
lepida ..	123
Pseudamnicola	23, 24, 223
macrostoma	27
Pseudococcinae	117
Psilorhynchus	162, 164
tentaculatus . ..	163
Psychoda bengalensis ..	250
Pterocles arenarius	128
arenarius caudacuta	128
Pterostichus	101
Pulmonata ..	18

Q

Querquedula crecca. .	133

R

Rana cyanophlyctis ..	245
cyanophlyctis seistanica	245, 249
esculenta .	244
esculenta ridibunda	244, 249
Rhynchota	236 237, 240
Rhynchota Heteroptera	205

S

Salix acmophylla	10
Salmonidae	154, 108, 186
Saxicola albinigra ..	124
capistrata	124
deserti	124
isabellina .	124
Scaphiodon	156, 158, 245
macmahoni	151, 152, 154, 156, 158, 160, 239, 249
muscatensis	159
Schistosoma japonicum	229, 231
Schistosomatidae	22
Schizocypris	154, 156, 175
brucei	151, 153, 156, 158, 176, 240, 241, 245, 249
Schizopygopsis	154, 156, 176, 240,
stoliczkae	151, 154, 156, 173, 239, 245, 249
Schizothoracinae	151, 152, 154—156, 168, 178, 240
Schizothorax	154, 156, 170, 176, 198
affinis	170
altior ..	173
brevis ..	170

	Page
Schizothorax intermedius	170
macrolepis	170
minutus	170
ritchianus	170
zarudnyi 151—154, 156, 165, 169, 170, 173, 176, 177, 192, 198, 232, 239—242, 245, 249	
Scirpus	10
littoralis	8, 194, 241
Segmentina	20, 52, 56
calathus 18, 19, 21, 40, 55, 56, 215, 238, 246, 250	
Siagona depressa	100
europaea	100
Siluroidea	186
Simocephalus exspinosus	146
vetulus	145, 237, 252
Sisoridae	186
Spatula clypeata	133
Spirogyra	79
Spongilla alba 83, 84, 86, 96, 241, 247	
*alba rhadinea	85, 253
carteri	83, 96, 247
fragilis	90
lacustris	84, 86
*lacustris ineptorum	86
lacustris montana	86
(Eunapius) carteri	87, 241, 253
Stenothyra	222
Sterna anglica	131
fluviatilis	131
hirundo	131
minuta	131
minuta gouldi	131
nilotica	131
Streptopelia turtur decaorta	127
Striatella	28, 34
Sturnus menzbieri	123
vulgaris nobilior	123
vulgaris poltaratskii	123
Succinea bensoni	114
Sylvia jerdoni	123
mystacea	121, 123
Symplecta elongata	238, 251
punctipennis	243, 251

T

	Page
Tadorna tadorna	133
Talorchestia	243
Tamarix articulata	118
stricta	118
Tellina	209
fluminalis	58, 209
Theobaldia longiareolata	236, 251
Theodoxia jordani	218
Theodoxis	216, 217
jordani	218,-219
michoni	218—220
Theodoxus	217
fluviatilis	217
Tichodromia muraria	123
Tinnunculus tinnunculus saturatus	127
Totanus glareola	130
totanus eurhinus	130
Tricula	221, 222
montana	221
palmyrae	222
Tringa alpina alpina	130
Turtur risorius	127
Typha	8, 242
angustifolia	241
angustata	194
latifolia	196

U

	Page
Unio	57, 59
Unionidae	18, 59, 160, 210

V

	Page
Vallisneria	9
spiralis	9
Valvata	27
Vivipara	19, 27, 246
dissimilis	27
(dissimilis) hilmendensis	27
hlimandica	239, 246, 247, 250
hlimandensis	17, 19—21, 27, 28, 240
sindica	246
Viviparidae	17, 27

X

	Page
Xiphidiocercaria	22

Z

	Page
Zannichellia	145
palustris	6, 47, 237, 238
Zaponia parva parva	128
pusilla	128

REPORT ON THE AQUATIC FAUNA OF SEISTAN.

Prefatory Note.

The series of papers of which the first instalment is now published will be based mainly on the collections made by Mr. S. W Kemp and myself in Seistan and Baluchistan in November, December and January, 1918-19. The main object of our tour was to enquire into the etiology of the disease Bilharziasis or Schistosomiasis, and particularly to discover whether the parasite occurred in Seistan, or whether any known intermediate molluscan host was found to be in that country. For this and other work on the zoological aspect of the disease a generous grant of money was made by the Council of the Indian Medical Research Fund. So far as it was concerned our results were entirely negative; but we took the opportunity to make as large and complete a collection of the aquatic fauna as the time at our disposal permitted. As this fauna is a limited one (*i.e.* includes few species but large numbers of individuals) we were able to obtain a more representative set of specimens than would have otherwise been the case. Our material, moreover, is supplemented by the specimens collected by the Seistan Boundary Commission of 1902-03 under the command of Sir Henry McMahon.

To Mr. Kemp my first acknowledgments are due. Indeed, a great part of the zoological success of our little expedition must be attributed to him. I only regret that it is impossible for his name to be more intimately associated with my own in the preparation of this report. The reason is the stress of other work and the necessity for a visit to Europe on his part. I have also to thank the political officers in Baluchistan and Seistan, in particular, Mr. B. J Gould, I.C.S., His Britannic Majesty's Consul in Seistan, Major D. Heron, I.M.S., C.I.E., Medical Officer and Vice-Consul, and Major W G. Hutchinson, Political Agent, Chagai. The officers serving on the Eastern Persian Cordon also gave us much assistance in the way of transport and supplies. Babu J N. Bagchi, Head Clerk, Zoological Survey of India, accompanied us and did good work. I have to thank Mr. E. Vredenburg of the Geological Survey of India for valuable suggestions embodied in the Introduction, while Dr. Baini Prashad, Offg. Director of Fisheries, Bengal, Bihar and Orissa, has helped me in various ways.

In examining the collection from Seistan it has been necessary also to examine much material of other *provenance*, and I have found it convenient to include in this volume certain studies of wider geographical scope.

N. ANNANDALE.

Calcutta,
17-v-19.

GEOGRAPHICAL INTRODUCTION.

By N. ANNANDALE, *D.Sc., F.A.S.B., Director, Zoological Survey of India.*

(With Plates I–II.)

Seistan and the Helmand River.

The Persian district of Seistan, at periods in its history an independent state and at others a part of Afghanistan, lies roughly between long. 61° and 62° E., lat. 30°50″ and 31°50″ N.; but its precise boundaries are not delimited to the west and south. It consists of the delta of the R. Helmand and the Hamun or basin into which that river flows. These lie, surrounded on all sides by stony desert, in a depression less than 2000 feet above sea level. The Helmand rises in the Hindu Khush in about lat. 68°40″ and long. 34°30″ and flows for three hundred miles through the mountains of Afghanistan, receiving many tributaries on its way. It then debouches on the desert plateau of Registan and, some distance after doing so, is joined by its largest tributary, the Arghandab. The course of the united waters, which flow in a deep bed through the desert, is S.S.W for some seventy miles. They are then deflected by a small range of hills through which they have been unable to cut their way, and continue westward, with a distinct southward bend, for about another hundred and fifty miles. Then, on reaching the southern limits of the old delta, the river breaks up into innumerable channels, partly natural, partly artificial, which turn northwards. In these channels, the chief of which is ultimately known as the Rud-i-Pariun, much of the water is dissipated, but what remains finally drains westward into the Hamun-i-Helmand or Hamun-i-Seistan, a large basin (or rather series of basins) which occupies a considerable but extremely variable area. After the junction of the Arghandab and the Helmand very little additional water, not nearly enough to compensate for evaporation, enters the system; for the desert is practically rainless, even in Seistan the rainfall is only a

little over 2½ inches a year,[1] and there are no permanent affluent streams. Seistan is a well-watered country, but its water-supply, like that of Egypt, depends not on local rainfall but on the rainfall and the snows in a mountainous region many miles away. The fact that, unlike most of the lake-systems of Central Asia and Persia, that of the Hamun-i-Seistan has not dried up is to be explained only by the peculiar course of the Helmand, the greater part of which traverses comparatively damp mountainous country.

The Hamun, however, is not the final repository of the soluble matter which the river inevitably brings into it. If it had been so, with its limited area, all its water would have been salt long ago. On maps of Persia and the adjacent countries a river, named the Shelagh (or Shila) river, is marked running southwards and eastwards from the Hamun into another basin, the Gaud-i-Zirreh, which occupies a very large area in the great desert of south-western Afghanistan. This is the Dead Sea of the

[1] The following tables of rainfall (in inches) are derived from official sources :—

Season.	Quetta.	Chaman.	Hindu Bagh.	Kabul.	Seistan.	Meshed.	Teheran.	Baghdad.
October to March ...	7·58	8·06	4·51	8·45	2·06	5·01	7·93	7·14
April to September ...	2·40	1·72	0·81	3·40	0·45	3·49	1·92	1·20
TOTAL ...	9·45	9·78	5·32	11·85	2·51	8·50	9·85	8·34

RAINFALL AT NASRATABAD, SEISTAN.

Month.	1902.	1903.	1904.	1905.	Total.	Average per month.
January ...	...	1·46	0·60	0·44	2·50	0·83
February ...	Not recorded.	0·42	0·15	0·28	0·85	0·28
March ...	...	0·97	0·19	0·37	1·53	0·51
April ...	0·03	1·19	...	...	1·22	0·41
May ...	...	0·05	...	...	0·05	0·02
June ...	...	0·07	...	...	0·07	0·02
July ...	...	...	...	...	...	...
August ...	...	...	...	...	...	...
September ...	...	...	...	...	...	...
October ...	0·27	...	...	...	0·27	0·09
November ...	0·17	0·07	0·06	...	0·30	0·10
December ...	0·60	0·13	0·01	...	0·74	0·25
TOTAL ...	1·07	4·36	1·01	1·09	7·43	2·51

Helmand system.[1] Except in times of exceptional flood the Shelagh is a deep stream-bed, dry except for scattered pools of water so saline that tamarisk twigs at the edge are coated half an inch thick with salt; but the water in flood-times, at the very site of these pools, becomes readily drinkable and the river is a raging torrent. Similarly the Gaud-i-Zirreh is at most seasons a wide plain covered with a thick deposit of salt and containing pools and swamps of saline water; but it may become a real lake for the time being, with water of comparatively but not actually low salinity.

The climate of Seistan, though regular from year to year, is one of considerable extremes and with only two seasons, summer and winter. In December and January the temperature usually falls below freezing point at night, while in summer it frequently rises to 115°F. in the shade by day, with a maximum of about 117° It is, however, very exceptional for the larger bodies of water to freeze completely, while the summer heat is tempered by an almost unceasing wind. Wind,[2] indeed, seems to be the most constant feature of the climate, and its direction seldom changes. The direction is about N.N.W For weeks on end in summer time it does not stop, and even in winter windy days are commoner than calm ones, and the wind is as a rule practically N.N.W Such rain as falls, falls mainly between the end of December and that of April, in which thunderstorms accompanied by hail and causing sudden floods sometimes occur; but the real flood-season takes place when the snows begin to melt in Afghanistan between March and May.

Different Types of Aquatic Environment in Seistan.

A summary description of the Helmand-system and the climate of Seistan has been necessary to explain the very existence of the Hamun-i-Helmand as a lake, and of an aquatic fauna in the country. A detailed account[3] of the system would be impossible

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[1] In high floods a certain amount of water runs from the Helmand direct into the southern part of the Hamun system through a channel probably of artificial origin, and in exceptionally high floods some may flow direct into the Gaud-i-Zirreh, but this is not the normal course.

[2] "At the end of May, or middle of June, the celebrated *bad-i-sad-o-bist rus* (120 days' wind) sets in and blows with but little cessation till the middle or end of September. It blows unceasingly for four or five days at a time, usually attaining its maximum daily velocity between midnight and 5 A.M and again between 8 A.M. and 5 P.M. It moderates a little in the early morning and evening. After four or five days it drops a little for a day or two, only to recommence with renewed violence. It blows with appalling violence, reaching the maximum velocity. as recorded by the Mission anemometers, of 72 miles per hour. It blows always from one direction, viz. a little west of north, i.e. between $316\frac{1}{2}^{\circ}$ and $333\frac{3}{4}^{\circ}$." (From an official document).

[3] The most complete account of the topography of Seistan yet published is to be found in Tate's *Seistan. A Memoir on the History, Topography, Ruins and People of the Country*, Parts I–IV (Calcutta, 1910 and 1912). See also McMahon "The Southern Borderland of Afghanistan," *Geog. Journ.* IX, pp. 393–415 (1897), *id.*, "Recent Survey and Exploration in Seistan," Vol. XXVIII, pp. 333–340 (1906), and Rawlinson "Notes on Seistan," *Journ. Roy. Geog. Soc.* XIII, pp. 272–294 (1873).

without further knowledge and greater space than are at my disposal. It is necessary, however, if the peculiarities of the fauna are to be demonstrated that a somewhat fuller description should be given of the physical conditions in which it lives. I have referred to Seistan as a well-watered country. One might go further and describe it as almost a water-logged country; and yet at first sight, at any rate in winter, it appears to be a desert of hard grey clay, only clothed with a sparse growth of camelthorn, only mitigated by the astounding play of the mirage. The apparent barrenness is because the soil is full of mineral salts dissolved in the water which permeates it a few feet below the surface. By capillary action the salts are drawn up towards the surface and assist in forming a hard, almost cement-like crust, which has to be removed before the operations of agriculture become possible. If a field or a garden be neglected for a few years a new crust of the kind is formed, and so it is only those parts of the country actually under cultivation that have any appearance of fertility.

The whole country is covered with a network of small water-channels ultimately connected with the branches or effluents of the Helmand. In these the flow of water is carefully regulated and for a great part of the year many of them are permanently or periodically dry. Even in their immediate vicinity the clay is almost lifeless. It is only in exceptional cases that the channels themselves support an aquatic vegetation, but in the one that supplies the Consulate garden at Nasratabad, there is a sparse vegetation of Characeae and *Potamogeton*, while in brick-pits close at hand on the parade-ground *Zannichellia palustris*,[1] L., grows with fair luxuriance. A green filamentous alga is more common and forms felt-like masses as it dries. These masses are often seen coating and sometimes completely burying the camelthorn in occasionally flooded country.

We did not have time to visit the main channels of the Helmand, but at a place near Jellalabad about twelve miles north-east of Nasratabad we examined the bed of one of the larger effluent streams. At the end of November, 1918 this stream-bed was almost dry, but shallow pools remained in which the water, though not very salt, was turbid and extremely foul owing to the presence of large flocks and herds which watered at the pool, and to the enormous number of small fish and mayfly larvae (*Palingenia*) that were dying in it. There was no vegetation in an active state in these pools, but peculiar roots with large globular swellings were still alive in the mud, and we found at some places the remains of reeds. Still nearer Nasratabad we examined a narrower but more active water-course, probably in part of artificial formation, which was connected with a small lake or large backwater. In this lake the only vegetation consisted of reeds in a withered condition, but

[1] I have to thank my friend Dr. H. G. Carter for the name of this and other plants mentioned in this report.

near it was a smaller pool in which were scattered plants, almost moribund, of a species of *Potamogeton.*

By far the most peculiar and most interesting body of water in the country, however, is that which occupies the Hamun. To appreciate the structure of the Hamun it must be realized that the word means lake-basin rather than lake, and is sometimes applied to large hollows that are quite dry. Moreover, in Seistan at any rate, it is used in a collective sense to indicate a whole series of basins only joined together in high floods. In this sense the full name is the Hamun-i-Seistan or Hamun-i-Helmand, but it is common to speak merely of the Hamun. On some maps of Persia and the adjacent countries the Helmand is shown as flowing into a compact body of water some eighty miles long and from ten to thirty broad. This state of affairs, however, only exists in exceptionally high floods and probably does not occur more than once in a decade. The Hamun is ordinarily divided into several distinct basins, of which two may be recognized as of most importance and most distinct. These may be conveniently referred to as the Hamun-i-Sabari and the Hamun-i-Koh-i-Khwaja. The Hamun-i-Sabari,[1] to use the name in the wider sense in which it is often used in Seistan, is the northern half of the Hamun-i-Seistan, and the only part of it that contains water not strongly saline at any season but flood-time. It rarely dries up completely. In normal winters it probably covers an area about ten to twenty miles long by six to twelve miles broad. The Rud-i-Pariun and other branches of the Helmand enters this basin on the eastern side. It is separated from the Hamun-i-Koh-i-Khwaja by a broad bar which is, except in flood-time, quite dry. Except at this season, the southern basin is dry or contains only pools of strongly saline water. It is only when the Hamun-i-Sabari overflows that it fills up, and when it itself overflows the Shelagh becomes a real river.

At the time of our visit the Hamun-i-Koh-i-Khwaja was said to be almost completely dry and we did not visit it. I shall confine my further remarks on the Hamun system, therefore, to the Hamun-i-Sabari. Of this lake we visited only the southern part, the northern extremity lying in Afghan territory.

The shores of this part of the Hamun are for the most part low and shelving, composed of mud more or less firmly caked and with frequent beds of reeds. Along the western shore there are, however, cliffs in some places over 50 feet high. The water reaches the base of these cliffs only in very high floods and the beach below them is strewn with water-worn pebbles. They are themselves composed of hard greenish-white clay formed of

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[1] On most maps, including those issued recently by the Survey of India, this name is confined to the extreme northern part of the system, which is often isolated if not completely dry, the more important basin into which the waters of the Helmand actually flow being left nameless. At Lab-i-Baring, however, the whole lake is called Hamun-i-Sabari.

very fine particles of even structure.[1] Along their summits a comparatively thin layer contains numerous pebbles similar to those that cover the surrounding desert,[2] and it is from this layer that the pebbles of the beach are derived. The cliffs themselves are being continually eaten away by wind and occasional rain and undermined by floods, which cause great blocks of clay to fall down on to the shore.

No trace of shells or other animal remains has been found in the clay of the cliffs. The clay of the bottom of the open lake in their vicinity is very similar in general appearance though naturally much softer, but contains empty shells of *Lamellidens* and *Corbicula* in a remarkably unworn condition.

The normal flood-level is marked on the shores of the lake by a drift-line consisting mainly of the broken stems and the inflorescences of reeds.

Perhaps the most prominent feature of this part of the Hamun is the enormous beds of reeds that cover a large part of its area. These reeds are of three kinds. Each kind grows separately but beds of each are to be found in the midst of those of the other two. The most abundant species is a form of *Phragmites* exactly intermediate, as my friend Dr. H. G. Carter informs me, between the Palaearctic *P. communis* and the Indian *P. kharka.* This reed covers hundreds of square miles in the flood season and gives its name (*nai*) to the Naizar or reed-country that affords valuable pasturage for sheep and cattle. When the floods sink the reeds die down as the soil dries, but those that have established themselves in deeper water flourish throughout the year. Next in abundance is *Scirpus littoralis*, which also covers large areas but does not extend so far out from the lake, and finally we have a bulrush of the genus *Typha*, which is rather less abundant than the other two species.

The reed-beds provide the means of life to two distinct classes of people who live on the shores of the Hamun—the Gaodar or cowherds and the Saiyads or hunters. The Gaodar have large herds of cattle, which they feed on the young shoots of *Phragmites* and *Typha*, both fresh and dry, and particularly on the *Scirpus.* Both tribes construct their dwellings entirely of *Phragmites*, and both make curious little skiffs, not unlike the papyrus skiffs of ancient Egypt, of the leaves of the bulrush—the only craft on the waters of Seistan.

The reed-beds are penetrated in all directions by narrow channels said to be made by the cattle of the Gaodar wading out to pasture, but probably kept open by the people themselves for use in bird-catching and fishing. The water in these channels is turbid near the shore of the lake but clear and of a yellowish tinge

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[1] For sections of the cliffs of Seistan see Huntington's account of "The Basin of Eastern Persia and Seistan" in *Explorations in Turkistan* (*Expedition of* 1903), published by the Carnegie Institution of Washington (1905).

[2] See Vredenburg, *Mem Geol. Surv. Ind.* XXXI, p. 179 (1901).

further among the reeds. The bottom is covered with a thin layer of peaty material, below which it is malodorous and black. It is as a rule from four to seven feet deep in the winter season. The channels widen out at intervals into open pools of two sorts, the larger of which are devoid of phanerogamic plants. Those of the smaller sort, which are rarely more than about six to ten yards wide, are rather deeper than the channels and are blocked with aquatic vegetation. This consists mainly of *Potamogeton pectinatus*, which with its narrow, grass-like leaves forms fairly dense masses from the bottom to the surface. Interspersed with it are single plants of *P. perfoliatus*, *Naias major* and Characeae. In the channels themselves single plants of *P. lucens* and at some places rather more densely congregated plants of *Vallisneria spiralis* form the only phanerogamic vegetation apart from the reeds.

The reeds act in all the channels and pools as a very effective wind-screen, so that even when a blizzard is blowing outside there is calm in the reed-beds. They also protect the water to some extent from frost.

Immediately outside the reed-beds, towards the open lake, there are at some places beds of *Potamogeton perfoliatus*, but the bottom of this part of the lake is usually bare. In calm weather the water is clear, but calm is exceptional in Seistan and as a rule it is turbid and of a milky appearance.

All the subaqueous plants of the Hamun are in a more or less moribund state in winter, the *Vallisneria* and *Potamogeton pectinatus* less so than the rest. Of the other species we found only occasional living shoots.

In the southern part of the Hamun-i-Sabari we made no sounding greater than 7½ feet, but rather deeper pockets are said to exist further north. It will be remembered, moreover, that our visit took place at the season at which the lake is almost at its lowest.

From a biological point of view the periodic and occasional changes in the level of the lake are of great importance. These are produced mainly by two causes, evaporation and changes in the supply from the Helmand due chiefly to the rate of melting of the snows of the Hindu Kush. The direction of the wind is so constant that its effects need not be considered. When it ceases to blow the water retreats a little but the result is quite temporary. In the year 1885, in which the Hamun was unusually full, the water reached its maximum in April, remained at its highest level up to the end of May and sank a little over three feet between that month and December.

In a climate like that of Seistan the loss of water by evaporation is very considerable in summer-time. The actual rate of evaporation apparently differs in different parts of the country in correlation with differences in the chemical composition of the water, being in the Gaud-i-Zirreh half of what it is in pools in the northern parts of Seistan. The whole question, however, is very

imperfectly understood and calls for further investigation. By calculation about ten feet of surface water should be lost annually from this cause in Seistan proper, but observations show that the actual amount is considerably less.

The loss of water through occasional failure of the Helmand supply is still more important to the aquatic fauna of the Hamun. Both fish and molluscs are said to have been abundant at one time in the lake, but it dried up completely in 1871 and again in 1903,[1] and since these dates the fauna is believed to have become much impoverished.

There is only one other kind of body of water to which I need refer here, viz. the springs that well up in the stony desert surrounding Seistan. These springs vary considerably in size and in salinity. None of them possess any great volume of water and few are quite fresh, the majority containing a more or less strong solution of magnesium sulphate, which has a devastating effect on the entrails of those who drink the water. An exception to this is to be found in the spring at Hurmuk, just across the Persian frontier and only a few miles from the point at which those of Persia, Afghanistan and Baluchistan meet. The water of this spring, which is fairly copious, is fresh and is stated locally to be the best in all Iran. Whether they be fresh or salt these springs are usually devoid of aquatic vegetation other than algae, at most, as at Saindak, having a scanty growth of *Potamogeton*, but a small *Scirpus* often grows at the edge, and the water is usually edged with willow trees (*Salix acmophylla*), perhaps planted. As a rule there is a small pool, more or less artificial, where the water comes out of the earth, with a streamlet or mere trickle passing from it into the desert and disappearing at no great distance.

Origin of the Hamun-i-Helmand.

It would be out of place in the present paper to discuss the geological history of Seistan[2] in any great detail, but there is one problem, that of the age of the Hamun, which has too important a bearing on the origin of the aquatic fauna to be entirely ignored. It has sometimes been assumed that the Hamun is the shrunken relic of a great freshwater lake, which has even been compared to the Caspian Sea. As I have already pointed out (*antea*, p. 4) the existence of a lake of practically fresh water in Seistan is to be explained by the peculiar course of the Helmand and by the fact that the whole system is occasionally flushed into the Gaud-i-Zirreh, and if, as the body of evidence[3] seems to show, the whole of

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[1] Huntington, E., "The depression of Seistan in Eastern Persia," *Bull. American Geog. Soc.* XXXVII, p. 276 (1905).

[2] See Huntington's account of "The Basin of Eastern Persia and Seistan" in *Explorations in Turkistan* (*Expedition of* 1903) published by the Carnegie Institution of Washington (1905).

[3] There is an extensive literature on this subject. For a good recent summary see the chapter on "The Ancient Climate of Iran" in Huntington's book "The Pulse of Asia" (London, 1907). Blanford's volume on the *Zoology and*

Eastern Persia and the neighbouring countries have become desiccated in the recent period, we may be certain that the basin of the Helmand contained more water at a period geologically not remote than it does now. More water must have entered the river, there must have been less loss by evaporation and possibly less by absorption in recent alluvium. Moreover, the structure of the Afghan-Baluch desert leaves little doubt that lakes of considerable area once existed within its confines, even if it never formed a single great lake-basin. It needs no great exercise of the imagination, for example, to believe that the Gaud-i-Zirreh, which is over eighty miles long and some twenty miles broad, was once a comparatively deep lake, which gradually silted up, as most lakes do in the course of time. Further, the clay of which the cliffs at Lab-i-Baring at the edge of the Hamun-i-Sabari (*antea*, p. 7) are composed has all the appearance in its fine texture, uniform structure and lack of stratification, of being a lake deposit.[1] My friend Mr. E. Vredenburg of the Geological Survey of India, who has been kind enough to examine specimens of this clay, reports that they closely resemble that of certain tertiary deposits in the Siwaliks which he believes to be of lacustrine origin. I have pointed out above (p. 8) that, *except in being totally devoid of animal remains*, it closely resembles the deposit now being formed at the bottom of the Hamun in the immediate vicinity of the cliffs.[2]

This, however, does not prove that the existing Hamun is the actual remains of an ancient freshwater lake. All that it indicates is that the Hamun occupies part of an old lake-basin. As the cliffs are over fifty feet high, this old basin must have contained a large body of water and existed for a long period, in order that so much silt should have been deposited.

The structure of the cliffs at this place is uniform except for a layer of a few feet on the surface. This layer is composed of dry earth more friable than the clay beneath it and full of water-worn pebbles, either of limestone or of volcanic origin. The following report on specimens of the limestone pebbles by Mr. Vredenburg shows that they do not differ from those found in the neighbouring desert[3] (with which this layer is, indeed, in continuity both structurally and geographically), and that, therefore, they have been brought from distant hills by occasional floods and not shaped by the waves of a lake. Mr. Vredenburg writes:—

"The three pebbles of dark-grey limestone contain a few specimens of *Nummulites atacicus*, Leym., a fossil characteristic of

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Geology in Eastern Persia, pp. 448–451, may also be consulted and the reports of the Expedition to Central Asia organized by the Carnegie Institution of Washington.

[1] Huntington, *op. cit.*, 1905, p. 285.

[2] It should be noted in this connection that in the Siwaliks proper of the sub-Himalayan area, which were not formed under desert conditions, freshwater fossil shells are abundant at certain places. Precise information about the species, etc., is, however, still lacking.

[3] See Blanford, *op. cit.*, p. 465 (London, 1876), and Vredenburg, *op. cit.*, p. 189.

the "Lybian" division of the eocene, a stage widely developed throughout the Mediterranean countries, and intermediate in age between the "Londinian" and "Parisian" of North-Western Europe where it is missing.

"This species is very scantily represented in the pebbles under examination, which are crowded with an *Alveolina* that occurs in profusion in the Lybian limestones of India which, consequently, have frequently been referred to under the name of "Alveolina limestones." Carter (*Journ. Bombay Br. Roy. As. Soc.*, Vol. V, p. 134, pl. ii, fig. 16, 1853), and d'Archiac and Haime (*Descr. an. foss. groupe numm. Inde.*, 1854, p. 348) have regarded this fossil as specifically identical with *A. sphaeroidea*, Lam. (*An. sans vert.*, 1822, Vol. VII, p. 615), which abounds amongst the rocks of the same age in the Pyrenean region.

"The Alveolina limestone, showing the same dark colour as the Seistan pebbles,[1] occurs in great abundance in the neighbourhood of Koh-i-Malik-Siah."

From this it follows that the deposit of which the cliffs are a section must have completely filled up the basin in which it was formed, at any rate at the site of the cliffs, and had been covered by a layer of entirely different and more recent origin that constitutes the surface of the desert over a great area in Persia, Afghanistan and Baluchistan.

The lack of animal remains in the clay of the cliffs at Lab-i-Baring is a very important difference between it and the deposit now being formed in the Hamun in their immediate vicinity. The freshwater shells found subfossil in many parts of Seistan are in a remarkably good state of preservation, while those of the individuals that still live in the Hamun are so free from erosion that even in adult individuals of *Lamellidens* the larval shell of the glochidium can often still be distinguished. It is, therefore, very improbable that shells, if they had ever existed in the cliffs, would have been completely destroyed. The lake of which the cliffs represented the bottom can, indeed, hardly have had a molluscan fauna. In this respect it resembled most Persian lakes, and the reason of its barrenness was the same:—its water was too salt, or rather contained too large a proportion of deleterious [2] salts in solution. The clay of the cliffs is consolidated with mineral salts and the little streams that arise in clay hills of exactly the same structure and run down through little gorges towards the lake contain water of such salinity that the salts crystallize out at their margin (*postea*, p. 15).

Now, the waters of the Helmand are fresh and those of Seistan become saline when they absorb salts from the soil. This was brought home to us in a very striking manner at Lab-i-Baring.

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[1] These pebbles have probably been brought by occasional floods from hills lying a considerable distance to the west or north-west of the lake.

[2] The macroscopic fauna of the saline streams in the cliffs at Lab-i-Baring consists of a few small insects.

While we were staying there the wind dropped and there was a dead calm for three days. The wind had previously been blowing from the north, the direction roughly from the point at which the Helmand enters the lake, and the water of the Hamun had been quite fresh to the taste. As soon as the Helmand water, however, ceased to be blown in our direction, that of the Hamun became perceptibly brackish. As the present Hamun system has an occasional outlet into the Gaud-i-Zirreh and its waters remain, at any rate in the Hamun-i-Sabari, fairly fresh because of the scouring of the floods, we may suppose that the salts in the soil round the basin near Lab-i-Baring are derived from an old lake which had no outlet of the kind.

There is much historical evidence that the outflow of the Helmand has moved northwards in recent times. For example, there are ruined cities in the south of Seistan where there is now no water at all, while ruins are exposed in the bed of the Hamun-i-Sabari in times of exceptionally low water. In its course through the desert the river has gradually cut for itself a deep bed. Before it did so its course may have been quite other than it is now, and the filling up and desiccation of lake-beds may have been correlated in a complex manner with changes in level. It is by no means improbable on general grounds that the river, as the Jordan does now, once terminated in a saline lake which was practically lifeless. Indeed, there is evidence that it did so in the historical period. I have to thank Mr. Vredenburg for the following note on this point:—

"With regard to the change in the course of the Helmand, it seems possible that the northward bend at the Band-i-Kamal Khan may be partly artificial. From the historical evidence of Arab geographers, this spot must correspond with the original head of the delta which, originally, therefore, would have spread mainly over Southern Seistan and would have communicated more directly than it does now with the Zirreh Lake. It is nevertheless conceivable that the diversion may have been natural or partly natural; the shifting beds of the distributaries, both natural and artificial, being gradually raised by the deposition of silt, a process which might have gradually involved the whole of Southern Seistan till the main body of the Helmand found an easier course northward. The present Hamun-i-Sabari, in its present relatively extended form, would be therefore quite modern—as shown, indeed, by the ruined city in its bed; though a comparatively small and intermittent pool may have previously been formed by the flood-waters of the Farah-Rud. It is also quite conceivable that, as it became increasingly difficult to keep open the irrigation channels in Southern Seistan, the Helmand may have been artificially deflected northwards over the more easily watered northern tract.

"So long as the delta spread chiefly over Southern Seistan, the Zirreh Lake must have been much more obviously and much more permanently than it is now the true termination of the Helmand system. The true relic of the large prehistoric lake alluded to by

Dr. Annandale would therefore be represented by the Zirreh Lake and not by the adventitious bodies of water in Northern Seistan, which, in their present form, are perhaps not more than six or seven centuries old.

"Whether the Shelagh is the original outlet of the whole body of water in times of exceptional flood also appears somewhat doubtful, and it is also quite possible that it has acquired its present importance within late historical times as a result of the silting up of the eastern portion of Southern Seistan. Originally the exceptional floods need not have collected as they do now in a single channel, but may have reached the Zirreh Lake directly through the various distributaries of a delta. Much more information than is at present available would be necessary to settle these various points which nevertheless are of great importance and interest from the various points of view of history, geology and physical geography."

The fauna of the Hamun shows no evidence of ancient origin, or of evolution in a great lake. It is a very poor fauna, as may be seen most readily by comparing it with that of the lake of Tiberias, in which the water is actually salter though other conditions are rather more favourable. From the Lake of Tiberias [1] twenty-five species of fish are known, from the Hamun only two; from the former at least fifteen species of molluscs, from the latter only five; from the former two species of Polyzoa, from the latter the same number; from the former five species of sponges, from the latter two. Moreover, the fauna of the Seistan Lake is by no means a highly specialized one. The fish belong to genera common either in the mountains of central Asia or in those of North-western India, the molluscs are closely related to widely-distributed Palaearctic forms, the sponges are cosmopolitan, while the Polyzoa are closely related either to tropical or to cosmopolitan forms. Had this fauna been lineally descended from that of a great lake, I cannot believe that it would have shown no trace of its origin.[2] Moreover, subfossil shells found in the neighbourhood of the Hamun are identical with the recent ones.

From all these facts and lines of argument it seems to me evident, firstly that the Hamun occupies in part the bed of an old salt lake, secondly that it has only a casual connection with that lake, and thirdly that in its present state it is of recent origin. There has been no biological continuity between the old lake and the recent one. I am not particularly concerned with the history and origin of the former, but I suppose that they were similar to those of other lakes in Persia.[3]

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[1] Annandale, *Journ. and Proc. As. Soc. Bengal* (New Series), Vol. XI, Nos. 10 and 11, p. 437 (1915).

[2] See Annandale, *Rec. Ind. Mus.* XIV, p. 172 (1918).

[3] See the works of Blanford and Huntington already cited, and also de Morgan's note in *Revue de L'Ecole D'Anthropologie for* 1907 (Paris), pp. 214–215.

The Water of Seistan.

We collected a considerable number of samples of water in the Hamun-i-Sabari and other bodies of water in Seistan, but unfortunately several of the bottles were broken on our journey. By the kindness of Dr. H. H. Hayden, F.R.S., Director of the Geological Survey of India, the samples that remain have been examined in the laboratory of that department. They are not sufficient to ensure an accurate and detailed analysis, but indicate with sufficient clearness the general character of the salts present. Our sample of water from the Shelagh river was lost, but one of the salts crystallized on its shore has been analysed.

The following are the results :—

Analysis of Water Samples from Seistan.

	From south shore of Hamun about 4 miles east of Lab-i-Baring. Between reed-beds and muddy shore.	From a small saline stream running down to but not quite reaching the Hamun. About a mile and half north of Lab-i-Baring.	From edge of Hamun about one mile north of Lab-i-Baring. On stony shore below cliff.
Quantity received	560 c.c.	500 c.c.	470 c.c.
	Given in grammes per 1000 c.c.		
Al_2O_3 and Fe_2O_5	*nil*	Trace	*nil*
CaO	0·0496	0·8629	0·0345
MgO ...	0·2220	2·4476	0·1542
Alkalies weighed as chlorides ...	1·4640	20·2650	0·9100
Na_2O ...	0·721	10·683	0·313
K_2O	0·0664	0·069	0·201
Cl	0·5293	10·8985	0·3399
SO_3	0·4759	5·2136	0·2948
Suspended matter	0·0426 grammes	0·1200 grammes	0·0872 grammes.

Analysis of Salt from the edge of Shelagh River, near Girdhi, Seistan.

Amount insoluble in boiling water	29·78
Al_2O_3 and Fe_2O_3	0·10
Ca	4·64
Mg	0·27
Na	13·10
K	2·57
Cl	15·62
SO_4	22·39
CO_3	1·14
Water of Composition .	10·75
Total	100·36

From this report it is evident that considerable amounts of salt are present even in waters that are potable, as that of the Hamun near Lab-i-Baring; that the salt is not merely sodium chloride but of mixed composition, and that its composition varies greatly even in the same part of the Hamun in different circumstances. I have already noted the changes in salinity produced in the water by a cessation of the normal wind (p. 13, *antea*). In both samples from the Hamun salts of sodium are the most prevalent, but salts of magnesium, which are usually more deleterious to animal life, are present in considerable quantity, and in one sample those of potassium are also fairly well represented.

The sample of water from the small stream was taken about a hundred yards up from the beach of the lake, in a little gully in the clay cliffs. The stream was a very small one and rose in clay among small hills at no great distance from the lake. We may take it as representing a solution of the soluble salts in the clay of the cliffs.

The salt from the margin of the Shelagh river, on the one hand, represents the offscouring [1] of the whole Hamun system. Here magnesium is poorly represented, while both sodium and potassium are present in fairly large amounts.

We have as yet no data, therefore, to estimate the differential effect of water of different chemical composition on the aquatic fauna of different parts of Seistan, and, indeed, to arrive at any results of the kind would necessitate a very long and arduous investigation carried out through the seasons and under all possible conditions of flood and the reverse. All that can be said is that the aquatic fauna throughout the country lives in abnormal and variable types of environment so far as the composition of the water is concerned.

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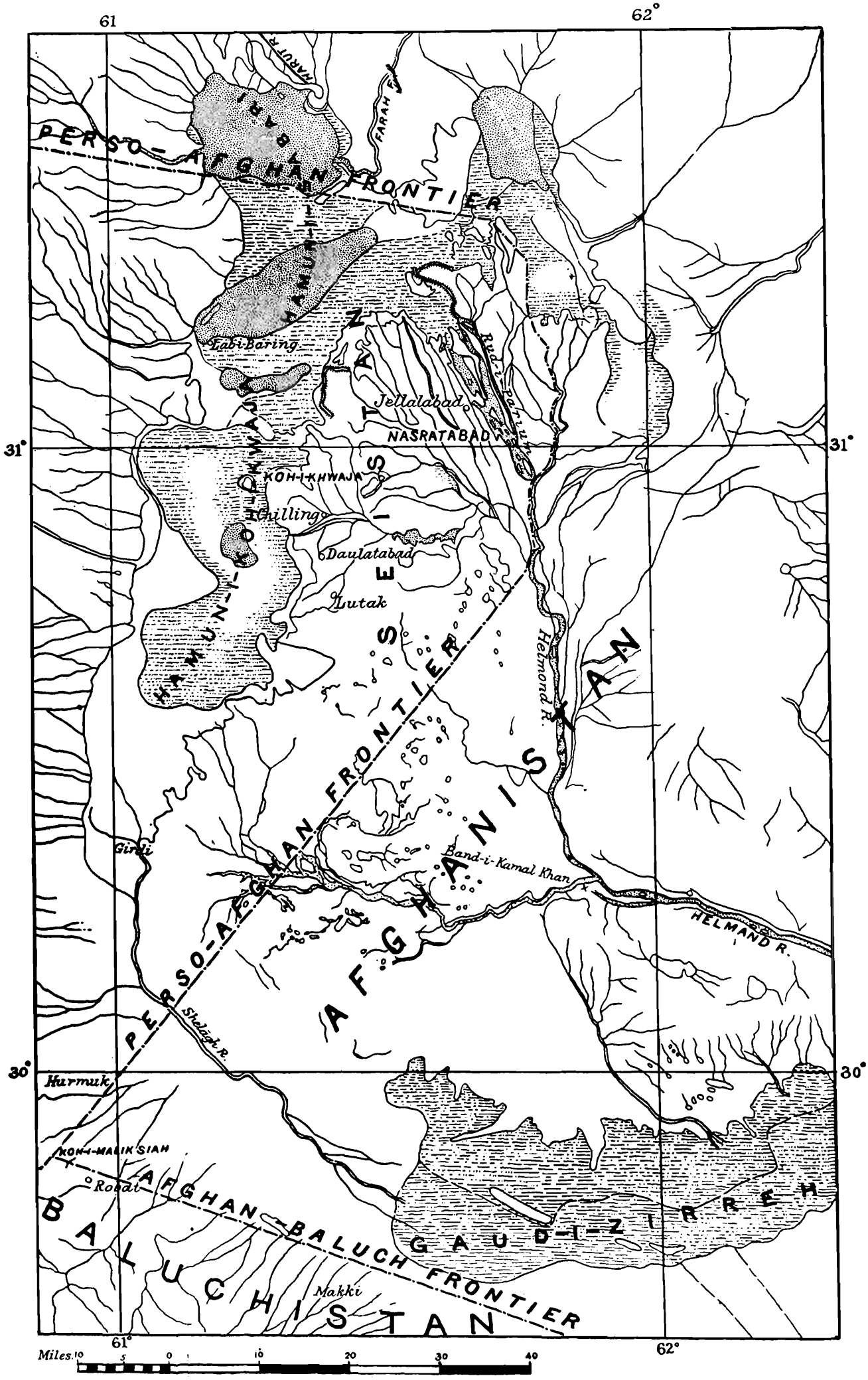
[1] It cannot, however, be composed of the same proportions of the different salts that occur in the water in solution, for some salts crystallize out before others.

EXPLANATION OF PLATE I.

MAP OF SEISTAN AND THE NEIGHBOURING COUNTRY.

Bodies of water that are permanent or practically so are shown densely dotted, while areas that are periodically or occasionally flooded are indicated by broken transverse lines.

Most of the water-courses marked on the map are usually dry.



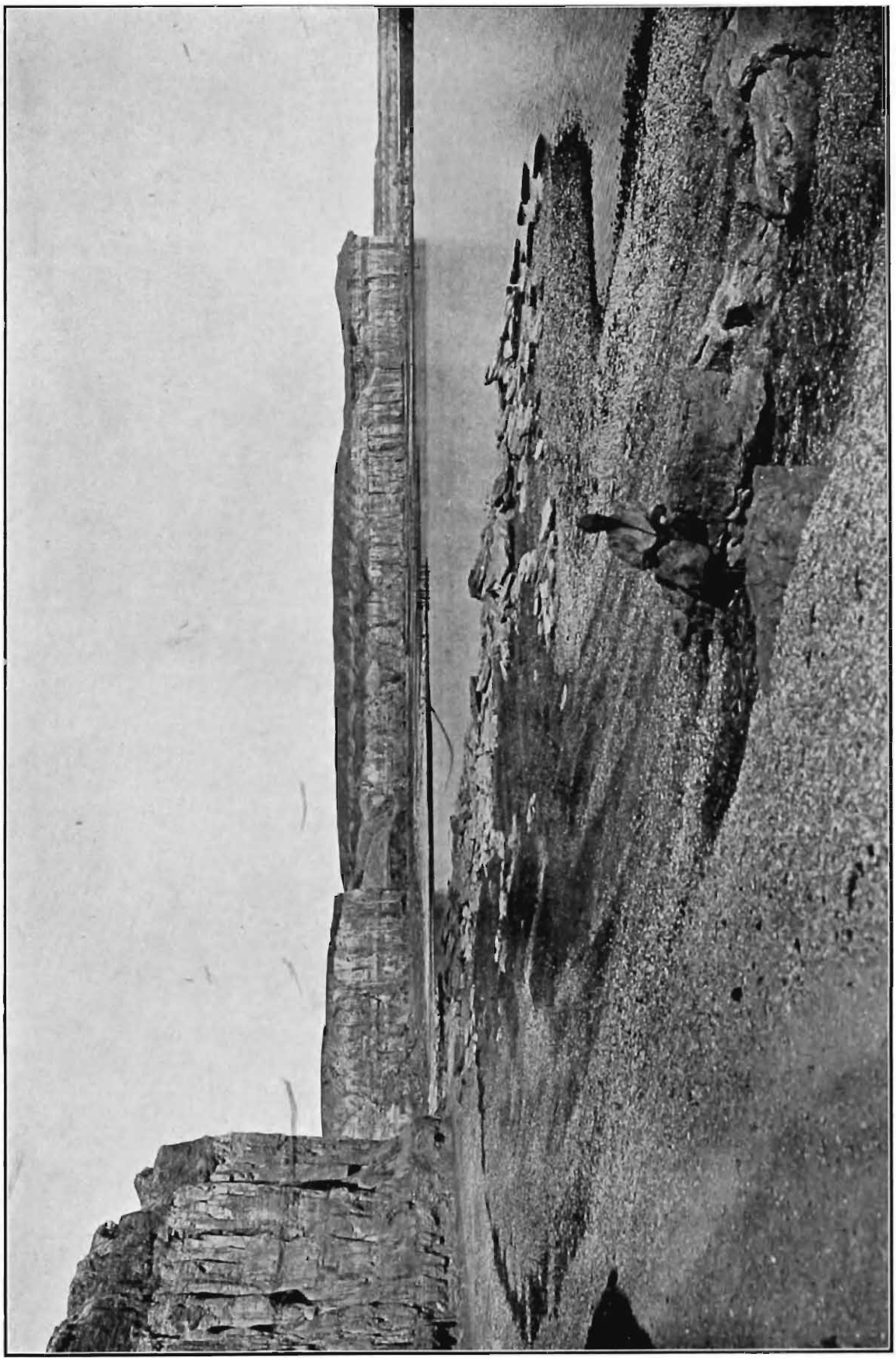
A. Chowdhary del.

EXPLANATION OF PLATE II.

CLIFF ON THE WESTERN SHORE OF THE HAMUN-I-HELMAND NEAR LAB-I-BARING. DECEMBER, 1918.

The photograph was taken on a calm day two days after the wind had fallen.

1. Uniform lacustrine deposit of stiff clay.
2. Superficial layer of more friable earth and water-worn pebbles.
3. Blocks of clay fallen from the cliff.
4. Beach of water-worn pebbles derived from superficial layer of cliff.
5. Normal flood-level marked by fragments of reeds and other vegetable debris.
6. Winter water-level in windy weather.
7. Water-level after two days' calm.
8. Footpath.
9. Reed-beds.



HAMUN NEAR LAB-I-BARING. Dec., 1918.

Photocentraved & printed at the Offices of the Survey of India, Calcutta, 1919.

THE MOLLUSCA OF THE INLAND WATERS OF BALUCHISTAN AND OF SEISTAN.

(With Plates III—VIII).

By N. ANNANDALE, *D.Sc., F.A.S.B., Director, Zoological Survey of India, and* BAINI PRASHAD, *D.Sc., Offg. Director of Fisheries, Bengal, Bihar and Orissa, with a note on the Liver-Fluke of Sheep in Seistan, by* S. W. KEMP, *B.A., Superintendent, Zoological Survey of India.*

In studying the aquatic Mollusca of Seistan we have found it necessary to study also those of Baluchistan, from certain parts of which abundant material was available. These parts are the hill-country of the Quetta and Pishin districts in Northern Baluchistan, in which one of us collected the material himself, the great Baluch-Afghan desert, in which a collection was made by Dr. N. Annandale and Mr. S. W. Kemp, and Persian Baluchistan, in which, many years ago, the late Dr. W. T. Blanford[1] obtained many specimens now in the Indian Museum. We have seen no shells from the British district of Mekran, which, however, marches with Persian Baluchistan on the west, from Las Bela and the neighbouring states, or from the Indus plain south of Sibi, in which the fauna is probably quite Indian.

The following is a list of the species and varieties now known, arranged according to the classification set forth by Pelseneer in Lankester's *Treatise on Zoology*, Vol. V (1906).

List of Freshwater Molluscs of Baluchistan and Seistan.

Gastropoda.

PECTINIBRANCHIA.

Fam. Hydrobiidae.	
Amnicola (*Alocinma*) *sistanica*, sp. nov.	Seistan.
? *Amnicola parvula* (Hutton).	N. Baluchistan.
Fam. Viviparidae.	
Vivipara hilmandensis, Kobelt.	Seistan; Afghan desert.
Fam. Melaniidae.	
Melanoides pyramis (Hutton).	N. Baluchistan.
M. pyramis var. *flavida* (Nevill).	W. Baluchistan.
M. pyramis var. *luteomarginata* (Nevill).	Persian Baluchistan; S. Persia.

[1] All the zoological collections made by Dr. Blanford and labelled "Baluchistan" are from this district, in which there happens to be a place called Pishin.

M tigrina (Hutton).	N. Baluchistan.
M scabra var. *elegans* (Hutton).	N. Baluchistan.
Melanopsis deserticola, sp. nov.	Persian Baluchistan.

PULMONATA.

Fam. Limnaeidae.	
Limnaea persica, Issel.	Baluchistan desert; S. Persia.
Limnaea iranica, sp. nov.	Persian Baluchistan.
Limnaea bactriana, Hutton.	N. Baluchistan; Seistan.
Limnaea gedrosiana, sp. nov.	Do. do.
L. gedrosiana var. *rectilabrum*, nov.	Do. do.
Limnaea truncatula, Gray.	N. Baluchistan.
Limnaea hordeum, Mousson.	Seistan.
Fam. Planorbidae.	
Gyraulus convexiusculus (Hutton).	N. Baluchistan; Seistan.
Gyraulus euphraticus, Mousson.	Do. do.
Segmentina calathus (Benson).	Seistan.

Lamellibranchia.

Fam. Unionidae.	
Lamellidens marginalis, subsp. *rhadinaeus*, subsp. nov.	Seistan; Afghan desert.
Fam. Cyrenidae.	
Corbicula fluminalis (Müller).	Baluchistan; Seistan.
? *Pisidium paludosum*, Hutton.	N. Baluchistan.

GEOGRAPHICAL DISTRIBUTION.

The molluscs to be considered in this paper come mainly from three districts, (1) the hill-country of Baluchistan watered (so far as it is watered at all) by the Lora or Pishin river, which has more or less saline water and makes its way down to the desert, where it disappears in the Zanginawar lakes; (2) Seistan, the delta and basin of the Helmand river, which rises in the Hindu Kush a considerable distance to the north of Baluchistan and passes a great body of fresh water, and (3) Persian Baluchistan, a mountainous district lying some considerable distance south of Seistan and reaching to the Arabian Sea. These three districts are separated by the great Afghan-Baluch desert, through which the Helmand flows. As even the desert is not devoid of aquatic molluscs, we have actually four districts to consider.

MOLLUSCA OF THE HILL-COUNTRY OF BALUCHISTAN. The molluscs of this district were described seventy years ago by Hutton, and we have no species to add to his list, though we do not accept all his identifications. The forms known from this district are:—

Melanoides pyramis.	*Melanoides scabra* var. *elegans.*
Melanoides tigrina.	? *Amnicola parvula.*

Limnaea bactriana.
Limnaea gedrosiana.
Limnaea gedrosiana var. *rectilabrum.*
Limnaea truncatula.
Gyraulus convexiusculus.
Gyraulus euphraticus.
Corbicula fluminalis.
? *Pisidium paludosum.*

MOLLUSCA OF THE AFGHAN-BALUCH DESERT. The following forms have been found in this desert:—

Melanoides pyramis var. *flavida.*
Vivipara hilmandensis.
Limnaea persica.
Gyraulus euphraticus.
Corbicula fluminalis.
Lamellidens marginalis subsp. *rhadinaeus.*

MOLLUSCA OF SEISTAN. In the alluvial plain of Seistan the following forms occur:—

Amnicola (*Alocinma*) *sistanica.*
Vivipara hilmandensis.
Limnaea bactriana.
Limnaea gedrosiana.
Limnaea gedrosiana var. *rectilabrum.*
Limnaea hordeum.
Gyraulus convexiusculus.
Gyraulus euphraticus.
Segmentina calathus.
Corbicula fluminalis.
Lamellidens marginalis subsp. *rhadinaeus.*

MOLLUSCA OF PERSIAN BALUCHISTAN. Most of the molluscs known from this district were obtained by the late Dr. W. T. Blanford, but Mr. W. J Good has recently added an interesting species. The following is a list of the known forms:—

Melanoides pyramis var. *flavida.*
Melanoides pyramis var. *luteomarginata.*
Melanoides scabra.
Melanopsis deserticola.
Limnaea iranica.

Of the lists, those of the species of the hill-country of Baluchistan and of Seistan are probably the most complete. Moreover, these two are very similar and the discrepancies between them are probably more apparent than real. In the Seistan list five (out of eleven) specific names are, indeed, present that are absent from the other, viz. *Amnicola sistanica*, *Vivipara hilmandensis*, *Limnaea hordeum*, *Segmentina calathus* and *Lamellidens marginalis*. The *Vivipara*, however, seems to be essentially a fluviatile species, probably unable to live in any but pure fresh water, and rivers with pure fresh water (or water of any kind) are proverbially scarce in Baluchistan; the *Limnaea*, which is also known from Mesopotamia, is exceedingly rare; *Segmentina calathus*, which is not uncommon at some places in the plains of North-western India, is local in its distribution, and the bivalve, though not yet found in Baluchistan, is common (in a distinct racial form) in the neighbouring country of Afghanistan. Of the species probably common to the two countries this bivalve is the only one in which even subspecific distinction is possible, but several others (e.g. *Limnaea gedrosiana*) exhibit slight local dfferences. *Amnicola sistanica* is the only species probably peculiar to Seistan, and

Limnaea hordeum (otherwise known only from lower Mesopotamia) the only true western form.

The Helmand, which, so far as the aquatic fauna is concerned, is the connecting link and the only highway for aquatic animals between the mountains of Baluchistan and eastern Afghanistan and the Seistan basin (or, indeed, between Seistan and all other countries), has naturally a molluscan fauna identical with that of the basin into which it flows. In the small springs of the desert, the water of most of which is more or less saline, only a few very tolerant species (e.g. *Gyraulus euphraticus* and *Corbicula fluminalis*, both of great geographical range) can live, and we found but one form (*Melanoides pyramis* var. *flavida*) probably peculiar to situations of the kind. It occurs in Persian Baluchistan as well as the Afghan-Baluch desert. *Limnaea persica* has only been found as yet in the southern part of the Persian plateau and in the basin of the Lora river in the eastern part of the desert.

The molluscan fauna of Persian Baluchistan is still imperfectly known, but the inclusion of a species of *Melanopsis* indicates the presence of a true western Asiatic element absent from other parts of the area under consideration.

The general absence of this western Asiatic element is perhaps the most striking feature of the fauna considered as a whole. Another point to be noted is the absence of certain large and conspicuous Palaearctic forms (e.g. *Limnaea stagnalis*) common in Kashmir at altitudes no higher than those of the Quetta district. This, however, does not imply that the fauna is essentially Oriental in the strict zoogeographical sense, for conditions of life are clearly inimical to large forms. The fauna is a starved one in which only species of great adaptability can survive. Such molluscs as *Vivipara hilmandensis* and *Lamellidens marginalis*, though evidently of Oriental origin, have spread into Palaearctic districts on the limits of their range, while the species of *Limnaea*, though here described as distinct, have a clear Palaearctic facies and most of them are probably descended from Palaearctic rather than true Indian forms, from which they differ considerably in all but one instance. The species of *Gyraulus* and *Segmentina*, though they occur in Oriental districts, are closely related to and probably derived from European forms.

The molluscan fauna of Seistan and Baluchistan, therefore, has little true geographical significance.

BIONOMICS.

The bionomics of the molluscan fauna of the inland waters of Baluchistan and Seistan are perhaps more interesting than its geographical distribution, but here again characters are negative. The fauna is one that lives habitually in water of abnormal chemical composition, for even potable water in these countries contains far more than its usual allowance of mineral salts (see p. 15, *antea*). The molluscs have not, however, responded to the

chemical stimulus with the facility sometimes associated with this factor in their environment, and are not particularly plastic or variable or at all exuberant in shell-sculpture. This is probably because other conditions are unfavourable—extremes of temperature, drought and lack of food—and the struggle for existence is too keen. The composition of the water has, indeed, had one effect, physical rather than biological, in preserving such sculpture as the shells possess intact from erosion. Probably it has acted indirectly, by discouraging the growth of corroding algae. But, even so, the *Limnaeae* do not develop the strong longitudinal ribs formed on the shells of those that live in saline waters in North America.[1]

The shells of all the species of Gastropods are small and in most cases very thin. They are of perfect form, neither distorted nor abnormal in other respects. Their colours, both of shell and soft parts, are pale. They constitute, in fact, a limited but very normal paludine fauna such as might be found in any temperate region.

No peculiar lacustrine species or even well-marked phases have as yet been evolved in the Hamun-i-Helmand.

In Seistan the recent geological history of the country has been of such a nature that subfossil shells are extremely abundant nearly everywhere except in the central parts of old lake-basins, while owing to the annual floods enormous numbers of quite recent shells are scattered over the country. In the deposits, both recent and historically ancient, examined both in the northern and the southern districts only two species were found (*Limnaea hordeum*, evidently a scarce form, and *Segmentina calathus*, a widely distributed but somewhat sporadic one) which were not found living in the country. The absence of Melaniidae from these deposits was a noteworthy feature. The commonest species in them at most places were *Amnicola sistanica*, *Limnaea gedrosiana*, *Gyraulus convexiusculus*, *G. euphraticus* and *Corbicula fluminalis*. At some spots, evidently those reached with fair regularity by recent floods, *Lamellidens marginalis* was also present in large numbers, and at one place *Vivipara hilmandensis* was common.

An interesting question in the bionomics of freshwater molluscs in a country like those under consideration is that of hibernation and aestivation and their effect on sexual activity. We give evidence below that certain species (mainly those of the genera *Melanoides*, *Corbicula* and *Lamellidens*) burrow into mud or sand either at the approach of winter or on the sinking of the annual floods. Perhaps this is also true of *Amnicola sistanica*. The Limnaeidae and Planorbidae, however, remain active throughout the winter. In Seistan and northern Baluchistan, and also at certain places in the North West Frontier Province, the eggs of

[1] See Baker, *Chicago Academy of Sciences*, special publication 3, p. 30 (1911).

Limnaea were observed in great abundance in November, December and January, and in females killed at this time of the year the female part of the reproductive organs was found to be in a state of activity. No individuals were, however, observed paired, and the male part of the hermaphrodite gland seems to be aborted. It is probable, therefore, that *Limnaea* is protandric in the peculiar conditions which exist in Seistan and Baluchistan, that pairing takes place in summer, and that the spermatozoa are stored up for considerable periods.

PARASITES AND INCOLAE.

The main object of the tour on the collections of which this paper is mainly based was to discover what could be discovered about the distribution of the aquatic molluscs and their trematode parasites in reference to the etiology of the disease Bilharziasis or Schistosomiasis. Living molluscs were examined in the field by Mr. S. W Kemp, who has been kind enough to supply us with the following information. His examinations were made in November and December.

The only molluscs in which trematodes were found in water brackish to the taste was *Melanoides pyramis* var. *flavida*. Of twenty-five individuals of this form from a small water-course at Saindak in the western part of the Baluchistan desert one was infected by the young rediae (indeterminate) probably of a *Xiphidocercaria*. The water was potable but tasted salt and bitter.

Sixty specimens of *Limnaea gedrosiana* from the reed-beds of the Hamun near Lab-i-Baring were examined and none found infected. Of another sixty of the var. *rectilabrum* of the same species from a small pool in the desert near Nasratabad only one was parasitized, its parasite being a small cercaria of the family Schistosomatidae. One hundred specimens of *L. bactriana* (fifty of the long-spired and fifty of the short-spired form) were examined at Nasratabad, from an irrigation channel. Ten contained trematode cercariae; in eight of these the parasite was a large monostome, while in one it was a Schistosomatid (apparently the same species found in *L. gedrosiana*) and in one the infection was a mixed infection of these two parasites.

Seventy-four specimens of *Gyraulus convexiusculus* from the reed-beds of the Hamun were examined and seven were found infected by Trematodes, two by indeterminate elongate sporocysts, three by Schistosomatid cercariae without eyespots and two by similar fork-tailed cercariae with eyespots. Only two specimens of *Gyraulus euphraticus* were examined, from the same locality; one was uninfected, while the other contained Schistosomatid cercariae without eyespots, apparently of the same species as was found in *G. convexiusculus*.

The Schistosomatid cercaria found in aquatic Pulmonate molluscs in Seistan does not appear to belong to any of the species known to parasitize man. A liver-fluke of the genus *Fasciola* (*s.s.*) is common in that country, but its cercariae were

not found, probably because their incidence is seasonal. Mr. Kemp has given us a note on this species (*F. gigantea*) which is appended to our paper. He hopes to describe all other parasites later.

Small red nematodes were common in *Gyraulus convexiusculus* in the Hamun in December.

The Oligochaete worm *Chaetogaster* was found in abundance at the edge of the mantle and in the branchial chamber of *Limnaea gedrosiana* var. *rectilabrum* in a pool in the desert near Nasratabad in the same month. Col. Stephenson has identified the worm as *Ch. bengalensis*, Annandale, a species common in Northern India.

SYSTEMATIC ACCOUNT OF THE FAUNA.

Class **GASTROPODA.**

Fam. HYDROBIIDAE.

1915. Paludestrinidae, Preston, *Faun. Brit. Ind., Freshw Moll.*, p. 67.
1919. Paludestrinidae, Godwin-Austen, *Rec. Ind. Mus.* XVI, p. 209.

Genus **Amnicola,** Gould and Haldeman.

1865. *Amnicola*, Stimpson, *Smiths. Misc. Coll.*, 201, p. 12.

The excellent account of this genus given in the work cited enables us to relegate to their proper genus certain Indian, Burmese and Persian species that have usually been placed in *Bithynia*. These species, however, differ in some respects from the American forms—sufficiently in our opinion to be regarded as constituting a new subgenus, for which we propose the name:—

Subgenus **Alocinma,** nov.

The shell agrees precisely with that of the American *Amnicola* and the Palaearctic *Pseudamnicola*, being globose or subglobose or slightly elongate, imperforate or subumbilicate, small, thick and smooth, with swollen whorls and having its mouth oval or ovate with a continuous but not greatly thickened peristome. The animal has a relatively short foot, which projects very little if at all beyond the shell. It is rounded or pointed behind and angulate in front. *The snout is long and narrow.* The tentacles are hardly longer than the shell, thin and filiform, and bear the eyes, which are small, at their base externally. The edge of the mantle is simple. The penis is large, flattened, lunate in outline and provided with a long and stout lateral process, which projects on the left side from its concave margin almost at right angles. It is situated almost in the middle of the "neck." *The operculum is of large size, and incapable of withdrawal into the shell, thick and calcareous but usually hyaline or subhyaline, distinctly spiral and with a slightly eccentric nucleus, but ornamented round the margin with concentric lines.*

The radula is very like that of *Amnicola*, *s.s.*, its central tooth being produced at either side and bearing a central process on its disk which projects downwards below its lower margin, as well as two or three lateral basal denticulations on each side.

Type-species. *Amnicola sistanica*, sp. nov.

This new subgenus is very closely related to *Amnicola*, *s.s.*, but differs in its long snout, calcareous oval or ovoid operculum and lunate penis. From *Pseudamnicola* it differs in its much larger, spiral operculum and in having more than one basal denticulation on each side of the central tooth of the radula. It is, indeed, a link between the two groups of species, each of which we regard as having subgeneric rank.

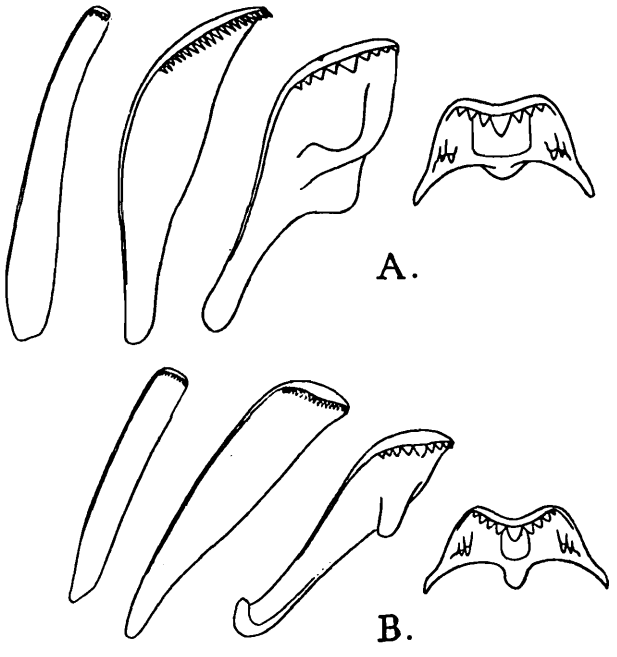


FIG. 1.—Radular teeth of *Amnicola* (× 500).

A. Teeth of *Amnicola* (*Alocinma*) *sistanica*, sp. nov., from the reed-beds of the Hamun-i-Helmand.

B. Teeth of *Amnicola* (*Alocinma*) *alticola* (Annandale), from the Inlé Lake, Southern Shan States.

Among the species that must be placed in the new subgenus are the common "*Bithynia*" *orcula* of Bengal and also *Amnicola alticola* (fig. 1 B) from the Southern Shan States. In the former as well as the latter the operculum is distinctly spiral and both have the other subgeneric characters.

Amnicola (Alocinma) sistanica, sp. nov.

(Pl. iii, figs. 1–5.)

This species is very closely related to *Amnicota orcula*, but the shell is more hyaline and more globose and has the suture more oblique and more impressed. It may be described as follows:—

The shell is small, ovato-conical, short, broad and obese, with five whorls, fairly thick but naturally quite colourless and hyaline, rapidly, however, becoming milky after the death of the animal, polished and ornamented with delicate longitudinal striae on the surface. The suture is impressed and very oblique, so that the spire is much longer in dorsal than in ventral view. The whorls increase rapidly in size and are highly convex; they are flattened outside the suture but rounded externally. The apex is minute but blunt and flattened. The basal whorl in ventral view is at least nearly three times as long as the spire, but these proportions are variable The mouth is large and somewhat expanded, oblique, never much longer than broad, ovate, rounded or bluntly pointed above and broadly rounded below. The peristome is continuous and there is a band-like callus on the inner lip. The outer lip is hardly thickened, but distinctly though slightly flattened and very narrowly retroverted; its inner corner is subangulate. The umbilicus is rimate and the columellar callus is expanded over it. The columella is straight.

Measurements of Shells (in millemetres).

	A	B	C	D	E	F
Length	6·5	8·2	7·8	7·2	5	3·8
Breadth	4·2	5·2	6·1	4·7	4	2·7
Length of mouth	2·5	3·1	3·7	3·2	2·4	1·9
Breadth of mouth	2	2·6	2·6	2·3	2	1·5

The operculum, which cannot be retracted into the shell, is when fresh of glassy transparency. It has three whorls. The nucleus is situated some distance from the antero-internal border. The shape is ovate, broadly rounded anteriorly and bluntly pointed posteriorly.

The radula is of the type normal in *Amnicola, s.s.* The central tooth is small and transverse, produced at each side into a bluntly pointed, narrow process, which points downwards and a little outwards. The disk bears a large quadrate raised area and a series of basal denticulations at each side, remote from both the lateral and the basal margin. In each series there are two distinct denticulations and an obscure, imperfectly developed external one. The upper margin of the tooth is slightly concave. The central cusp is enlarged and there are several smaller denticulations on each side of it; all are triangular, at least as long as broad at the base, and pointed at the tip. The lateral tooth is broad above but slender towards the base. It bears numerous small sharp cusps, the central one of which is slightly enlarged on the inner lateral. This tooth bears a broad blunt process on its disk and has its inner margin broadly and irregularly emarginate below. The outer marginal is very long and narrow, but broadens somewhat at the base. Its cusps are very minute and sharp.

The intromittent organ of the male is of relatively large size and distinctly flattened. Its external (right) margin is semi-circu-

lar and its internal margin concave in the same degree. The tip is pointed. The internal margin bears near its middle a long straight process terminating in a crateriform sucker-like structure, from the centre of which protrudes an elongate muscular papilla. The main body is smooth, the process obscurely annulate. Before entering the penis the vas deferens is highly convoluted and would be of immense length if unravelled. In the penis it pursues a sinuous course near the concave margin and remains distinct nearly to the aperture at the tip of the organ. The outer part of the penis appears to be glandular internally, but is provided with a well-developed layer of transverse muscle fibres externally.

The living animal was thus described in the field:—"Animal white with black clouding and minute golden yellow specks on the mantle; a suffusion of black pigment on the snout and tentacles. Tentacles slender, when fully expanded no longer than shell. Eyes small, black, prominent, situated near the base of the tentacles

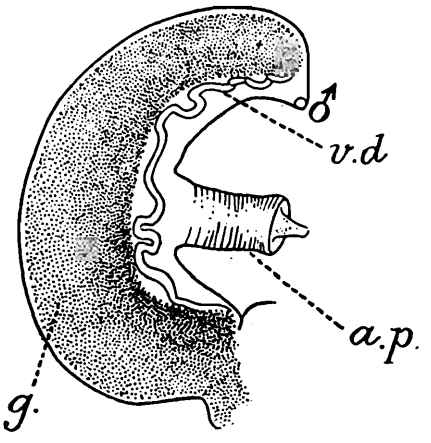


FIG. 2.—Male intromittent organ of *Amnicola* (*Alocinma*) *sistanica*, sp. nov. (×20), seen from below.

a.p.=accessory appendage: *g.*=glandular region: *v.d.*=vas deferens.

externally. Snout rather long and narrow, with parallel sides, slightly notched in front. Foot relatively small, rounded in front and bluntly angulate at the anterior corners, bluntly pointed behind."

Type-specimens. M 11538/2, Zoological Survey of India (Ind. Mus.).

Distribution. All over the dry *Naizar* or reed-country of northern Seistan shells of this species are common in the soil, as they are also in the debris of floods. We found fresh shells in the larger pools in the reed-beds of the Hamun near Lab-i-Baring and a few living individuals among the algae on the roots of *Phragmites* in narrow channels in the same beds.

These living individuals, which were very scarce, were all small and were only found in protected situations. Very large numbers of the mollusc evidently perish annually with the sinking of the floods and the majority of those that survive probably burrow into the mud and hibernate in winter.

The shell of this species bears a close resemblance, perhaps superficial, to that of the Syrian "*Paludina*" *badiella* as figured by Küster,[1] but the mouth is broader, the umbilicus narrower, the whorls less flattened above and pigment entirely absent. There has been much confusion about this Syrian species and we have no means of estimating the true relationship, if any exists, between it and our Seistan mollusc. There is also a resemblance to *Pseudamnicola macrostoma* from Greece, specimens of which we have examined; but the operculum of that species is much thinner, of different structure and of small size as compared with the mouth of the shell, which is much smaller than that of the Persian species.

? **Amnicola parvula** (Hutton).

1850. *Paludina parvula*, Hutton, *Journ. As. Soc. Bengal* (2) XVIII, p. 655.
1876. *Amnicola parvula*, Hanley and Theobald, *Conch. Ind.*, p. XVII, pl. cli, figs. 8, 9.

We have not seen this species and have no means of ascertaining its true generic and subgeneric position. Hutton says that the operculum is horny, and it would appear, therefore, to belong possibly to *Amnicola*, *s.s.* The other known species of this subgenus are, however, American. Nevill's[2] *Bithynia orcula* var. *parvula* is quite distinct and probably a true variety of *Amnicola* (*Alocinma*) *orcula* (Frauenfeld).

Hutton's species was found in a marshy patch of ground in the Kojak Pass at Chaman (Chammun), now on the Afghan frontier of Northern Baluchistan.

Family VIVIPARIDAE.

Genus **Vivipara**, Montfort.

Vivipara hilmendensis, Kobelt.

1909. *Vivipara* (*dissimilis* var.?) *hilmendensis*, Kobelt, *Paludina* in Martini and Chemnitz's *Conch-Cab.* (*ed.* Küster and Kobelt), p. 289, pl. lix, figs. 9–12.

The complete synonymy of the forms included by Kobelt under the name *Vivipara dissimilis* has not yet been worked out, and we leave the Helmand form provisionally as a distinct species. We have very little to add to Kobelt's description except that the natural colour of the shell is dark olivaceous with curious round whitish spots, and that the opercula of the specimens he examined were unnaturally thin owing perhaps to sand erosion.

The species was described from the Afghan desert and is

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[1] Küster, "*Paludina*, *Hydrocena* and *Valvata* in Martini and Chemnitz's *Conch. Cab.* (*ed.* Schubert and Wagner), p. 62, pl. xi, figs. 25–28 (1852).
[2] Nevill, *Hand List Moll. Ind. Mus.* II, p. 37 (1885).

evidently rare in most parts of Seistan. Single fairly fresh but empty shells were collected at the edge of pools near Nasratabad and Jellalabad and at that of the Hamun near Lab-i-Baring, while a considerable number of bleached specimens were also observed in the soil of occasionally flooded country near Chilling towards the south of Seistan. It is not improbable, therefore, that *V hilmendensis* is common on the banks of the lower Helmand and is essentially a fluviatile species.

Type-series. M 5087/1, Zoological Survey of India (Ind. Mus.).

Family MELANIIDAE.

Melanoides, Olivier.

1807. *Melanoides*, Olivier, *Voy. l'Emp. Ottoman* II, p. 40.
1854. *Plotia*, N. and A. Adams, *Gen. Rec. Moll.*, p. 295.
1874. *Plotia+Striatella* (? in part), Brot, *Melaniaceen* in Martini and Chemnitz, *Conch. Cab.* (*ed.* Küster), p. 7.
1897. *Melanoides+Plotia*, v. Martens, "*Suss. und Brackw. Moll.*", pp. 50, 62 in Weber's *Zool. Ergebn. Niederl.-Ost-Indien* IV.
1898. Neomelanien, P. and F. Sarasin, *Sussw. Moll. Celebes*, p. 38.
1915. *Striatella+Plotia*, Preston, *Faun. Brit. Ind., Freshw. Moll.*, pp. 15, 35.

In discussing the species of *Melania* (*s.l.*) that occur in Baluchistan and Seistan we have had to overcome two difficulties, firstly to settle the somewhat complicated specific synonomy, and secondly, to decide what characters should be regarded as of generic importance. So far as the second of these questions is concerned we have followed in the main the classification adopted by the Sarasins in the work cited above. We have, however, regarded the groups that they include under the name *Melania* as of generic value, believing that by so doing we are following sound lines in estimating such structures as the operculum and radula as of equal value in this family to the sculpture of the shell and the precise form of its mouth. The groups or subgenera *Plotia*, and *Striatella* (= *Melanoides*) as defined by Brot in his monograph and accepted by Preston in the *Fauna of India*, fade imperceptibly one into the other, and Brot's diagnosis of *Plotia* is, as we have pointed out elsewhere,[1] by no means applicable to all shells even of the type-species.

The question of specific identity and nomenclature in the Indian and Persian species of the genus is complicated by imperfect descriptions, particularly on the part of Troschel and Philippi.

In considering the question due but not excessive attention must be given to the locality of specimens and it must be remembered that the names *Melania pyramis* and *M elegans* are due to Hutton, and not to Benson, who merely distinguished certain forms by letters, and that, further, Hutton was dealing very largely

[1] *Rec. Ind. Mus.* XIV p. 147 (1919).

when he first used these names with a collection from what is now British Baluchistan and the Afghan frontier. We have been greatly helped by an examination of specimens named by Hutton himself.

The conclusions to which we have come are these, (1) that three species, one of which has several varieties, have been as yet found in Baluchistan and the extreme south of Persia; (2) that

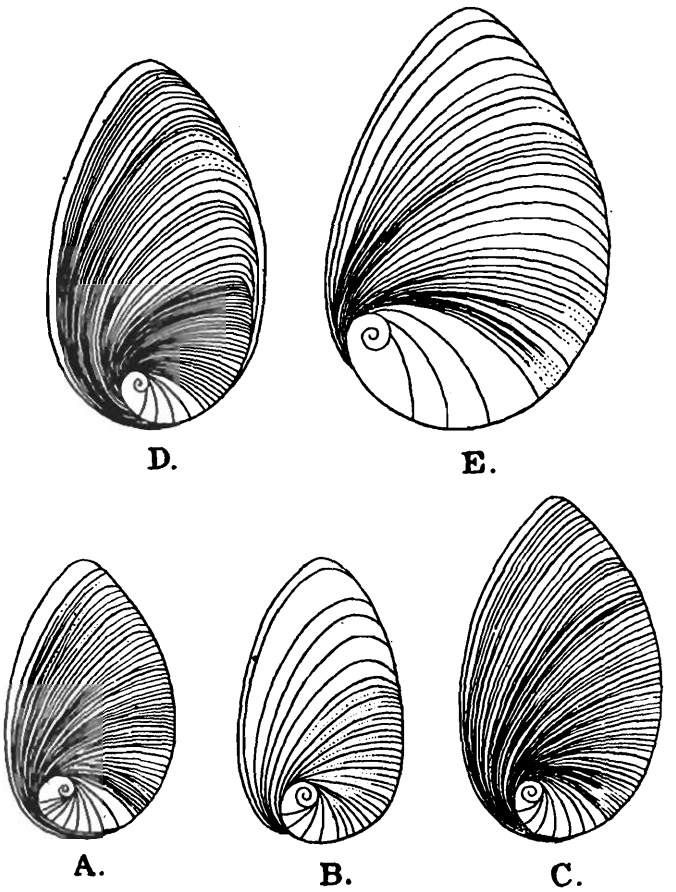

FIG. 3.—Opercula of Melaniidae.

A. *Melanoides tuberculata* (Müller), from large artificial reservoir in Hyderabad State.
B. *M. pyramis* var. *flavida* (Nevill), from spring in the Afghan-Baluch desert.
C. *M. pyramis* var. *luteomarginata* (Nevill), from Persian Baluchistan.
D. *M. tigrina* (Hutton) from Quetta.
E. *Melanopsis deserticola*, sp. nov. from a spring in Persian Baluchistan.

the correct names of these species are *Melanoides scabra* var. *elegans* (Hutton), *M. tigrina* (Hutton) and *M. pyramis* (Hutton); (3) that Hutton has included forms of two distinct species under the name *M. elegans*, and (4) that while one of these forms must be regarded as a variety of *M. scabra*, the other is a variety of *M. pyramis*. In our opinion the last is a transitional form be-

tween the groups *Plotia* and *Melanoides*, but comes in the latter rather than the former.

The genus *Melanoides* may be defined thus:—Melaniidae in

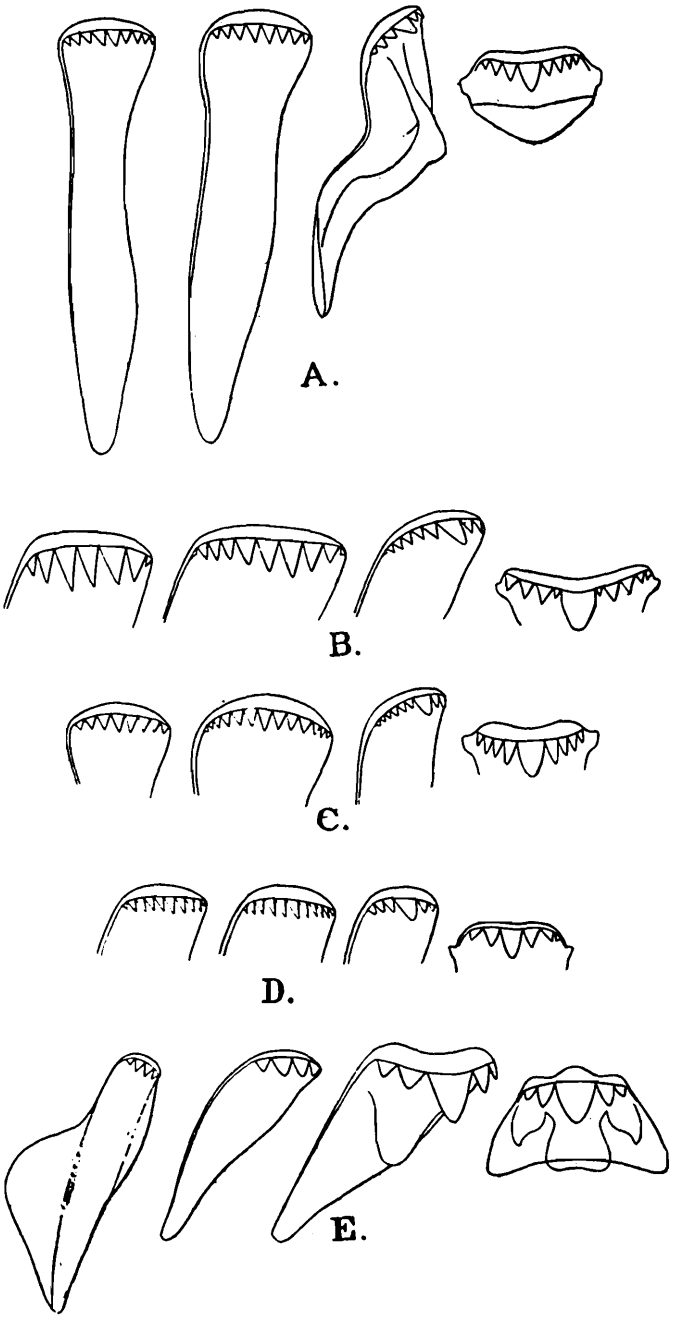

FIG. 4.—Radular teeth of Melaniidae (× 125).

A. Teeth of *Melanoides tigrina* (Hutton) from Quetta.
B. Upper part of teeth of *M. pyramis* var. *luteomarginata* (Nevill) from Persian Baluchistan.
C. Upper part of teeth of *M. pyramis* var. *leopardina*, var. nov. from Poona.
D. Upper part of teeth of *M. pyramis* var. *flavida* (Nevill) from spring in Afghan-Baluch desert.
E. Teeth of *Melanopsis deserticola*, sp. nov. from spring in Persian Baluchistan.

which the *shell* is small or of moderate size, tapering or turreted and never of very great thickness or relative breadth. The mouth is small, ovoid and not greatly produced in front; the columellar

callus moderate; the columella bent but slight and not produced anteriorly; the lip slightly or not at all thickened. The sculpture consists of longitudinal and transverse striae, which produce by their intersection a more or less granular appearance at any rate on the upper whorls. Longitudinal ribs may be present on the lower whorls; their distal extremity is either granular or spinose, as a rule more or less produced. The periostracum is thick and may bear minute hair-like processes.

The *operculum* is ovoid and relatively large, with the posterior extremity pointed. It is distinctly spiral towards the anterior, blunt extremity, but the actual whorls are relatively small and are situated near the inner anterior margin. The remainder of the surface is ornamented with curved parallel lines which radiate outwards from a point situated between the spiral region and the inner margin.

The *radular teeth* are characterized by their sharp and relatively numerous cusps. The lateral tooth is narrow, very oblique in its natural position and as a rule strongly curved or bent longitudinally.

Type-species. *M fasciolata*, Olivier=*M. tuberculata* (Müller), var.

[**Melanoides tuberculata** (Müller).]

(Pl. iv, fig. 1.)

1774. *Nerita tuberculata*, Müller, *Hist. Verm.*, p. 191.
1837. *Melania adspersa*, Troschel, Wiegm. *Arch. f. Naturw.* I, p. 175.
1876. *Melania tuberculata*, Hanley and Theobald, *Conch. Ind.*, pl. lxxiv, figs. 1-4.
1918. *Melania tuberculata*, Annandale, *Rec. Ind. Mus.* XIV, pp. 114, 156, fig. 6, pl. xii, figs. 1, 2.
1919. *Melania tuberculata*, Annandale and Prashad, *Ibid.*, XVI, p. 146, pl. v, fig. 5 (radula).

Although this species is extremely plastic, in some respects it retains its specific characters under all circumstances. These are (1) the very gradual and even increase in size of the whorls from the apex to the mouth, (2) the distinct but not very great convexity of the whorls, (3) the absence of all swelling and comparatively small size of the body-whorl, (4) the small size of the mouth of the shell, the maximum length of which is considerably less than one-third of the total length, (5) the tubercular sculpture, especially of the upper whorls, (6) the smooth spiral ridges at the base of the body-whorl, (7) the more or less distinct longitudinal reddish markings on a background of green or brown. The total length of the shell is from a little less than three to four times the greatest transverse diameter.

We have recently figured the radular teeth (*op. cit.*, 1919, pl. v, fig. 5). The central tooth is broad and rounded at the lateral angles. It is symmetrical or nearly so and has a comparatively small central cusp with four small ones on either side. The other teeth are sub-equal and a little narrower. They have numerous small cusps. In the inner marginal one of the cusps is a little enlarged.

The operculum is regularly ovoid, bluntly pointed posteriorly and broadly rounded anteriorly. It is distinctly spiral, with two and a half whorls in the nucleus, which is situated some distance from the inner margin. The surface is ornamented with numerous lines which curve outwards from near the anterior extremity.

In spite of its extremely wide range, from the Mediterranean to Australia and China, we have no evidence of the occurrence of this species in Baluchistan or Southern Persia.

Melanoides pyramis (Hutton).

(Pl. iv, fig. 3.)

1850. *Melania pyramis* (Benson), Hutton, *Journ. As. Soc. Bengal* (2) XVIII, p. 658.

This species is distinguished from *M. tuberculata* both by shell-characters and by constant differences in the radula. The shell is considerably shorter and broader, being distinctly less than three times as long as broad. The body-whorl is relatively large and much more swollen. The mouth is more than one-third as long as the shell, which tapers much more abruptly.

The radula of forms we regard as varieties differs considerably from that of *M tuberculata* in the shape of its central tooth, which is produced on either side in an angle, below which it is more or less constricted. It has a relatively large central cusp with the lateral cusps usually more numerous on the right side than the left. The lateral tooth is considerably narrower than the inner marginal.

We have not been able to examine fresh specimens of the typical form of this species, but Hutton states that the form which occurs in marshy land at Quetta is without markings and coarse in sculpture with the apex of the spire and epidermis eroded. A few dead shells of this type were found in a pond in the Residency garden at Quetta in January 1919, but no living individuals could be discovered in spite of a careful search. It is probable that in cold districts the species burrows into mud, as Hutton (*loc. cit.*, p. 657; 1850) states that *M scabra* var. *elegans* does in the same country.

Measurements of Shells (in millimetres).

Length	20·5	24·6
Breadth	7·3	9·1
Length of aperture.	7	8·7
Breadth of aperture	3·8	4·5

The shell we figure is much eroded, though the most complete we have examined in other respects. In a broken specimen of rather smaller size all the whorls but the body-whorl are ornamented with numerous curved longitudinal rows of from four to six tubercles separated by deep longitudinal grooves and divided up by narrow transverse striae.

We are able to recognize no less than four distinct varieties of this species.

[var. **leopardina**, nov.]

(Pl. iv, fig. 4.)

1876. *Melania pyramis* and var. *adspersa*, Hanley and Theobald (*nec* Troschel) *Conch. Ind.*, pl. cx, figs. 1, 2, 4.
1877. *Melania adspersa*, Brot (*nec* Troschel), *op. cit.*, p. 255, pl. xxvi, figs. 4, 4*a*.
1885. *Melania* (*Striatella*) *tuberculata*, Nevill, *Hand List Moll. Ind. Mus.*, II, p. 240 (in part).

This form has almost the same proportions as the *forma typica*, but the body whorl is slightly narrower and the anterior margin of the lip less produced. The surface of the shell is of a pale yellow colour beautifully marked with irregular longitudinal streaks of deep red. The sculpture is similar to that of the typical form but the granules are not so distinct. The shell is considerably thinner.

Measurements of Shells (*in millimetres*).

Length	28·2	28·4	22·3
Breadth	9·7	9.9	8·1
Length of aperture	9·9	10	8·2
Breadth of aperature	5·3	5·3	4·4

Type-series. 1202, Zoological Survey of India (Ind. Mus.) (from Poona).

The denticulations of the teeth of the radula are all rather blunt. The central tooth has four small cusps on each side of the central cusp. Its upper margin is slightly concave. None of the denticulations of the lateral teeth are much enlarged, the inner marginal has about thirteen and the outer about eight denticulations.

We figure the operculum.

This form appears to be the one to which the name *pyramis* has been most commonly applied. The measurements given by Troschel of his type-specimens of *Melania adspersa*, in which the apex was destroyed, preclude their belonging to it. It is not uncommon, though apparently somewhat sporadic, in the Indo-Gangetic plain and Peninsular India, but has often been confused with *M. tuberculata*.

[var. **puteicola**, nov.]

(Pl. iv, figs. 7–8.)

1834. *Melania* (No. 14), Hutton, *Journ. As. Soc. Bengal* III, p. 91.
1885. *Melania* (*Plotia*) *scabra* var. *elegans*, Nevill (specimens from Ferozepore only), *op. cit.*, p. 284.

As we have already pointed out, two quite distinct forms were confused by Nevill, and apparently at one time by Benson and Hutton, under the name *Melania elegans*. The specimens we describe here are those which Hutton found in a well at Ferozepore in the Punjab. They are the only shells we have seen.

Type-series. M 115401/2, Zoological Survey of India (Ind. Mus.).

The shells are similar in shape to *M pyramis*, s.s., but much smaller and thinner and with the lip slightly thickened anteriorly and the suture more impressed. Some of them, but not all, are characterized by the strong longitudinal sculpture of the upper whorls. The ribs, however, are not well defined and barely even distinctly tubercular, never at all produced, at their upper extremity. The surface is of neutral olivaceous buff with red longitudinal markings.

Measurements of Shells (in millimetres).

Length	15·3	15·7	14·8
Breadth	5·7	6	5·9
Length of aperture	6·2	6·3	6
Breadth of aperture	2·9	3	2·8

These shells, though clearly belonging to *M. pyramis*, afford an easy transition to the group *Plotia*, s.s. The fact that Nevill assigned them to *M scabra* is, indeed, strong evidence in favour of the advisability of breaking down the separation between that group and *Striatella*.

var. **flavida** (Nevill).

(Pl. iii, fig. 6; pl. iv, fig. 6.)

1885. *Melania* (*Striatella*) *tuberculata*, subvar. *flavida*, Nevill, *op. cit.*, p. 244.

Nevill gives no description of this variety. Shells exhibit considerable variation in shape, but are usually even broader than the typical form, and have the mouth more expanded and more oblique. The longitudinal ribs are quite obsolete. There is an indistinct smooth ridge running below the suture. The shell is moderately thin and resembles the var. *puteicola*, but is usually paler in colour. Sometimes, however, the colour approaches that of the var. *luteomarginata* and the sutural ridge is often distinctly paler than the remainder of the surface.

Measurements of Shells (in millimetres).

	Hurmuk			Persian Baluchistan.		
Length	19·6	15·5	17·2	30·7	27·4	25·2
Breadth	6·2	5	7	10·3	9·9	7·7
Length of aperture	6·4	4·9	6·7	10·9	9·7	7·2
Breadth of aperture	3·8	2·7	4	6·2	5·8	4·9

The central tooth of the radula is produced at either side into a distinct angle and is asymmetrical. It has three cusps on the left side of the middle enlarged, one and two on the right. The lateral tooth is considerably narrower but has very similar cusps. The marginal teeth are subequal, both broader than the lateral, and have a large number (at least ten) of sharp cusps on each.

The operculum has a distinct notch at the lower margin but is otherwise very like that of *M. tuberculata*, except that it bears fewer curved transverse striae.

Nevill named this variety from specimens from Pishin (not to be confused with the Pishin north of Quetta) and other localities in Persian Baluchistan and from Kalagan and Kerman in the south-east of Persia proper, and we have seen a rather dark shell from lower Mesopotamia.

Type-series. The specimens from the first of those districts may be regarded as the type-series, No. M. 11541/2, Zoological Survey of India (Ind. Mus.).

This form is not uncommon in small springs in the desert of Baluchistan and the Persian frontier. We collected specimens at Saindak and Robat in water distinctly salt to the taste, and at Hurmuk in fresh water. The following description of the animal is copied from the station book of the expedition:—

"Foot hardly longer than broad, subquadrate, with both extremities subtruncate; the antero-lateral angles acute and slightly produced. The snout long, flattened, rather narrow. The tentacles very slender, as a rule hardly longer than the snout. Processes at margin of mantle elongate, pointed, 7 or 8 in number. Sole of foot greyish white, with a faint tinge of pink and an indistinct grey border, spotted with microscopic yellow specks. Dorsal surface of foot, whole of snout, tentacles and edge of mantle black, the snout clouded with white, especially towards the base, the tentacles minutely speckled with dull yellow, the mantle processes edged and tipped with black. The animal moves with the ordinary jerky gait and holds its shell parallel to the surface when moving. When at rest the apex is often held sloping upwards."

var. **luteomarginata** (Nevill).

(Pl. iv, fig. 5.)

1885. *Melania tuberculata* subvar. *luteomarginata*, Nevill, *op. cit.*, p. 244.

This is a very beautiful and distinct variety distinguished by its regularity of form, colouration and sculpture. It is, however, linked by intermediate individuals with the var. *flavida*. The form is narrower than that of *M. pyramis* (*s.s.*), but the difference is not great. The colour is a deep chocolate-brown without reddish markings but rendered distinctive by the narrow paler spiral band that runs down the shell just outside the suture. The lower part of the inner margin of the mouth of the shell is also of the same colour. The sculpture, except at the base of the body-whorl, has a regular granulose appearance due to the fact that the longitudinal striae are numerous and not much deeper or broader than the transverse ones, and there is a narrow flattened ridge outside the suture. At the base of the shell only the transverse, spiral striae are developed. The shell is moderately thick.

Measurements of the Shells (in millimetres).

	Persian, Baluchistan (*Blanford*).		
Length . .	37·2	29.1	29·4
Breadth	13	9·9	10·8
Length of aperture .	11·1	10·2	10·3
Breadth of aperture .	6·4	5·5	6·3

Type-series. 1205, Zoological Survey of India (Ind. Mus.).

We have extracted the operculum and radula from one of Blanford's specimens. The former does not differ much from that of *M tuberculata* but is rather larger and more pointed posteriorly.

The radula, while of the same type as that of the vars. *leopardina* and *flavida*, differs slightly in the proportions and denticulation of teeth (see fig. 4), all of which are larger and broader than those of var. *flavida*. The central tooth has two extra cusps on either side and the cusps of the other teeth are much larger. Those on the outer marginal are fewer, not more than seven.

The variety is represented in the collection of the Zoological Survey of India by specimens collected by the late Dr. W T. Blanford in Persian Baluchistan and at Kalagan in the south of Persia proper.

Melanoides tigrina (Hutton).

(Pl. iv, fig. 2.)

1850. *Melania tigrina*, Hutton, *Journ. As. Soc. Bengal* (2), XVIII, p. 658.

This species is, as Hutton pointed out in his original description, distinguished from all varieties of *M pyramis* by the much greater smoothness of the shell, in which both the longitudinal and the transverse striae become almost obsolete towards the base. The shell resembles that of *M. pyramis* var. *leopardina* in shape, texture and colouration, but exhibits some variation in the extent to which the longitudinal reddish markings are developed. The specimens collected by Hutton and still in the Indian Museum are, as he stated, much eroded on the surface and have lost the apical whorls. We have examined, however, other examples from Quetta which are almost perfect. The shell only differs in form from that of *M. pyramis* var. *leopardina* in being still more acutely pointed, in having the whorls a little less convex and the suture slightly impressed owing mainly to a narrow flattening of the upper margin of each whorl. The sculpture on the upper whorls, in unworn shells, is distinctly though minutely granular, but it becomes gradually less distinct towards the body-whorl, on which only a comparatively small number of lightly impressed spiral striae and very indistinct longitudinal striae can be distinguished.

Measurements of Shells (in millimetres).

	Quetta.		
Length	34·6	33·2	32
Breadth	10·8	11·3	11·2
Length of aperture	10·6	10·5	11·1
Breadth of aperture	6·1	6·2	6

The radula is very like that of the varieties of *M. pyramis.*

The operculum is very similar to that of the varieties of *M. pyramis.*

The geographical range of this species is obscure and there has evidently been much confusion with *M. pyramis* and *M. tuberculata.* The only specimens we have examined are from Quetta and the Kangra Valley. They include Hutton's type-series (No. 1208 M, *Z.S.I.*).

Melanoides scabra (Müller) var. **elegans** (Hutton).

1850. *Melania elegans*, Hutton, *op. cit.*, p. 657.
1885. *Melania scabra* var. *elegans*, Nevill, *op. cit.*, p. 284 (in part).

To judge from Hutton's description, this is a large, thick, strongly sculptured and brilliantly coloured form of Müller's *Buccinum scabrum*, the specific name of which must be applied in a restricted sense to the smaller, thinner-shelled form with definite spines at the upper end of the longitudinal ribs on the body-whorl, common in South India.

We can find in the collection no specimens either from the Bolan Pass, which lies between Quetta and the plains, or from Sibb in Persian Baluchistan, from which place Nevill records specimens of the typical form. There is, however, a series stated, perhaps incorrectly, to be from the Sunderbans in the Gangetic Delta which agrees well with Hutton's description and with the remarks made by Nevill in his "Hand-List." We figure one of these shells.

The complete synonymy of *M. scabra* and its allies has still to be worked out. So far as we can say at present, the form *elegans* should not be regarded as having specific value.

Genus **Melanopsis**, Férussac.

1877. *Melanopsis*, Brot., *op. cit.*, p. 416.

This genus is represented in the southern part of the Persian Plateau[1] by several species. We have recently obtained from Persian Baluchistan a good series of specimens of a very distinct new form, for which we propose the name:—

Melanopsis deserticola, sp. nov.

(Pl. iii, fig. 8.)

The shell is smooth as a whole, tapering regularly, acuminate, fusiform, a little more than twice as long as broad. The whorls,

[1] See Nevill, *Hand List Moll. Ind. Mus.* II, pp. 206–209.

of which there are at least eight in complete shells, increase very gradually and regularly and are not at all swollen. The suture is not impressed but is, at any rate above the body-whorl, slightly undercut downwards. It is a little oblique. The spire is relatively long, nearly as long as the body-whorl in ventral and longer than that whorl in dorsal view. It is sharply pointed in the complete shell. The body-whorl is relatively narrow, much longer than broad and almost oblong in ventral view. In dorsal view the outer profile is in a straight line with that of the spire for about a third of its length and then curves abruptly inwards. The outer anterior angle is pointed and slightly produced. The mouth is rather small and relatively broad, slightly oblique and distinctly constricted posteriorly. The outer lip, which is not thickened, is sinuate and convex in its anterior part. The columella projects slightly; it is bent and its callus is moderate. The posterior canal of the mouth is short, narrow and straight. The surface of the shell is sculptured with coarse longitudinal striae, some of which on the body-whorl are irregularly thickened. In very old individuals these may have the appearance of obsolete ribs. The colour is normally a dull purplish black with the upper part of each whorl and the base of the body-whorl slightly paler; but some shells are bleached.

Measurements of Shells (in millimetres).

			Type-sp.
Length	14·4	13·6	13·3
Breadth	6·3	6·1	6·2
Length of aperture	6	5·8	6·1
Breadth of aperture	3·2	3·1	3·3
Length of spire (dorsal)	7·3	6·9	6·4

The operculum is thick and has the nuclear region small and obscurely spiral.

The animal is much shrunk in the specimens examined, but some interesting features of its external anatomy are apparent. The snout is relatively short and broad and slightly notched in front. The foot is much longer that broad. The tentacles, in a contracted condition, are very short, tapering and not very thick. They bear a relatively large oculiferous lobe at their outer base. The eye is also large. The upper surface of the exposed parts is blackish with white transverse lines, the sole white.

The radular teeth are large and rather stout. The central tooth is much broader than high. It is produced into blunt angles at the base on either side. Its upper margin bears three low prominences, while the lower margin is concave. There are five cusps, of which the central cusp is more than twice as long as the others; all are bluntly pointed and directed downwards. The disk bears a very large trilobed process with the central lobe broad and truncate, the lateral lobes pointed and with sinuate inner margins. The

lateral tooth is oblique but not bent. It has five cusps resembling those of the central tooth and bears a broad blunt process on its disk. The inner marginal has four or five subequal cusps and is much narrower than the outer. The outer marginal is relatively long and narrow as a whole, with four small cusps; but its outer margin is produced some distance below its upper edge into a broad, blunt lobe. On the upper part of the inner margin there is a similar but much less prominent projection.

Type-specimens. No. M 11535/2 *Zool. Surv. Ind.* (*Ind. Mus.*).

The type-series was found by Mr. (temporary Major) W. J Good, at the time Administrative Commandant, South Central District, Eastern Persian Cordon, at Kaindak (long. 60° 48′ E., lat. 29° 48′N.), Persian Baluchistan. The molluscs were collected on damp alga at the edge of a small spring of slightly brackish water. The water comes out of a patch of earth 20 to 30 feet square and forms a mere trickle.

At first sight the shell of this species is very like that of the dwarfed Persian form of *M. praerosa* (Linn.) called by Nevill var. *nana*. It is, however, considerably narrower and more acuminate and has the spire very much longer.

Family LIMNAEIDAE.

The molluscs of this family found in Baluchistan and Seistan all belong to the genus *Limnaea* in a wide sense, but fall into two very distinct groups, which we may call provisionally the group of *L. auricularia* and that of *L. truncatula*. Until the anatomy of the Limnaeidae of India and of Western Asia is better known it would be premature to discuss the nomenclature and status of these groups. To that of *L. auricularia* belong *L. persica*, *L. bactriana*, *L. iranica* and *L. gedrosiana*, while *L. truncatula* and *L. hordeum* represent the group of the former species.

Genus **Limnaea**, Lamarck.

The *Limnaeae* found in the countries under consideration are all of small size and, except those of *L. truncatula* group, have thin, fragile shells, which are unpigmented or of very pale colouration. They are all paludine forms. We have recognized six species. Although some of these resemble Palaearctic or Indian species in shell-characters, we have not felt justified in identifying any but the plastic *L. truncatula* with species known either from Europe, from Central Asia or from India. One peculiar species (*L. hordeum*) we assign, after a comparison of specimens, to a Mesopotamian form. The resemblances in the shell in other instances are no more than resemblances, and in most cases precise information as to anatomical characters is deficient or altogether lacking.

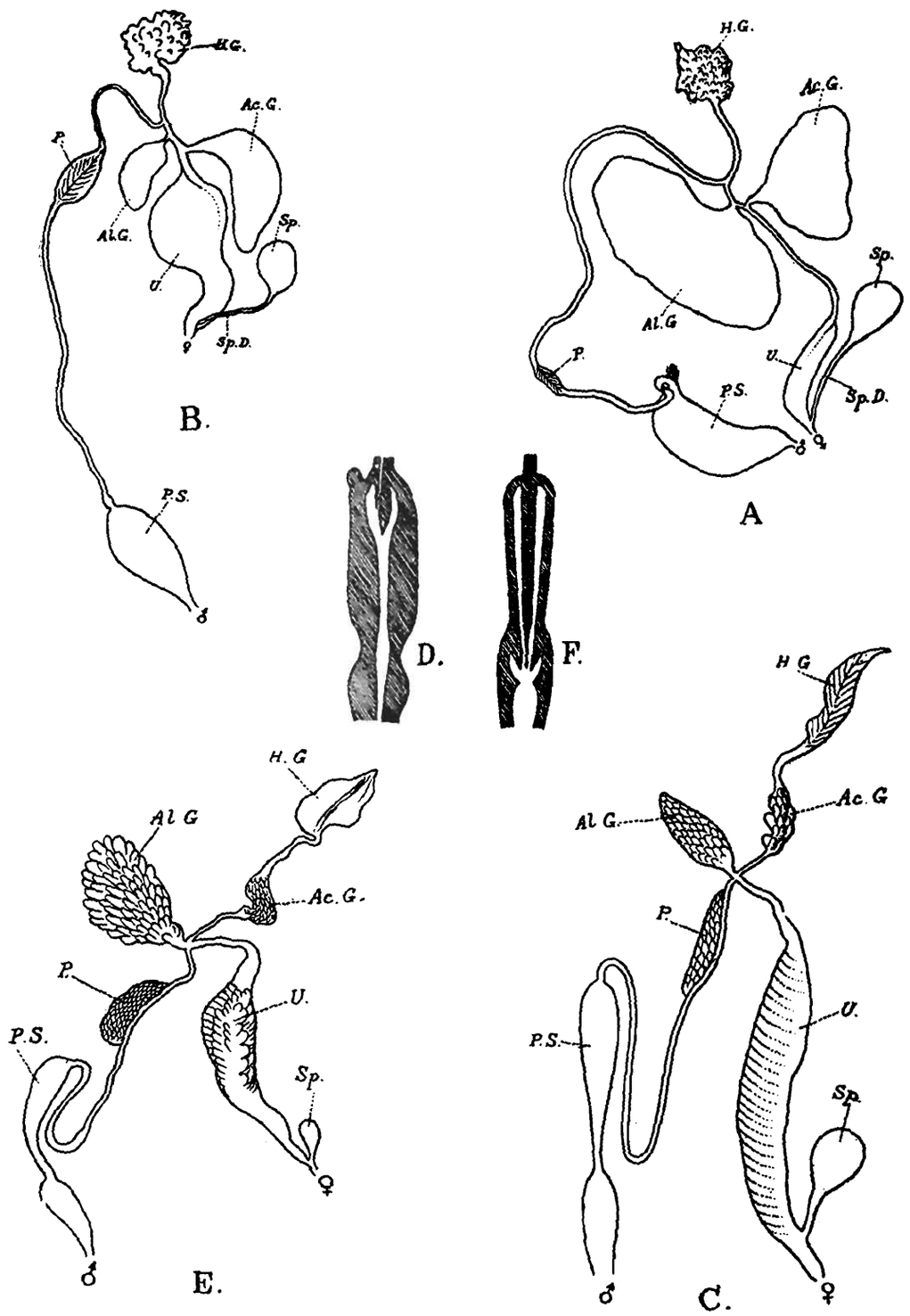

FIG. 5.—Genitalia of Pulmonate Molluscs.

A. Genitalia of *L. bactriana*, Hutton.
B. Genitalia of *Limnaea gedrosiana* var. *rectilabrum*, var. nov.
C. Genitalia of *Gyraulus euphraticus*, Mousson.
D. Penis-sheath of same specimen as seen in optical section (further enlarged).
E. Genitalia of *Gyraulus convexiusculus* (Hutton).
F. Penis-sheath of *Segmentina calathus* (Benson) as seen in optical section (× 35).

Key to the Shells of Limnaea *known from Baluchistan and Seistan.*

1. Shell thin, moderately small; its mouth large and more than half as long as the shell.
   - A. Mouth expanded and projecting posteriorly from shell at a right angle; its outer arc practically a semi-circle ... ... *L. persica.*
   - B. Mouth not or little expanded, usually projecting at an angle much less than a right angle; its outer arc less than a semi-circle.
     - i. Spire exserted, with swollen whorls and impressed suture; main axis of mouth forming an acute angle with that of shell ... *L. bactriana.*
     - ii. Spire much less exserted; its whorls not swollen and its suture not impressed; main axis of mouth parallel to that of shell.
       - a. Outer arc of mouth quite regular; apex sharply pointed ... ... *L. iranica.*
       - b. Outer arc of mouth irregular; apex bluntly pointed.
         1. Curve of outer arc of mouth only slightly flattened ... ... *L. gedrosiana, s.s.*
         2. Curve of outer arc of mouth flattened to a straight line ... ... *L. gedrosiana* var. *rectilabrum.*

2. Shell moderately or very thick, of very small size, elongate, with the length of the mouth much less than half the total length.
   1. Apex pointed; whorls of spire moderate ... *L. truncatula.*
   2. Apex blunt; whorls of spire very large ... *L. hordeum.*

Limnaea persica, Issel.

(Pl. v, figs. 3–6.)

1865. *Limnaea auricularia* var. *persica*, Bourguignat, Issel, *Moll. Miss. Ital. Persia* (*Torino*), p. 47.
1883. *Limnaea persica*, Locard, *Arch. Mus. Hist. Nat. Lyon* III, p. 285.

Issel gave a very brief description of this form, which he did not figure, merely comparing it with *L. auricularia* and stating the length and breadth of the shell. Locard had probably seen specimens, as he compared his *L. subpersica* with it, but gave no further details. It seems to us impossible that the form which Nevill[1] called *Limnaeus lagotis* var. *persica*, Issel (= *L. iranica*, nobis) can be identical, as that form has no particular resemblance to *L. auricularia.*

We have before us a series of shells[2] collected by the late Dr. W. T. Blanford at Saidabad, S.W of Kerman (the type locality). The measurements of one of these agree almost precisely with those given by Issel. We have also a much larger series from the Baluchistan desert clearly belonging to the same species but differing slightly. Fully adult shells from the former locality are somewhat broader than Issel's type, the specimen that agrees with it being not quite full-grown, and we do not know from what kind of

[1] Nevill, *Hand List Moll. Ind. Mus.* I, p. 237 (1879).
[2] Identified by Nevill as *L. auricularia*, var. (*op. cit.*, p. 238).

environment either Philippi's or Blanford's specimens came. It is possible, therefore, either that Issel's type was immature, or that the specimens from the desert are more near the typical form than those which chanced to be collected in the same district as it. We will describe and figure shells from the Kerman district and point out the characters wherein those from the desert (examples of which we also figure) differ from them.

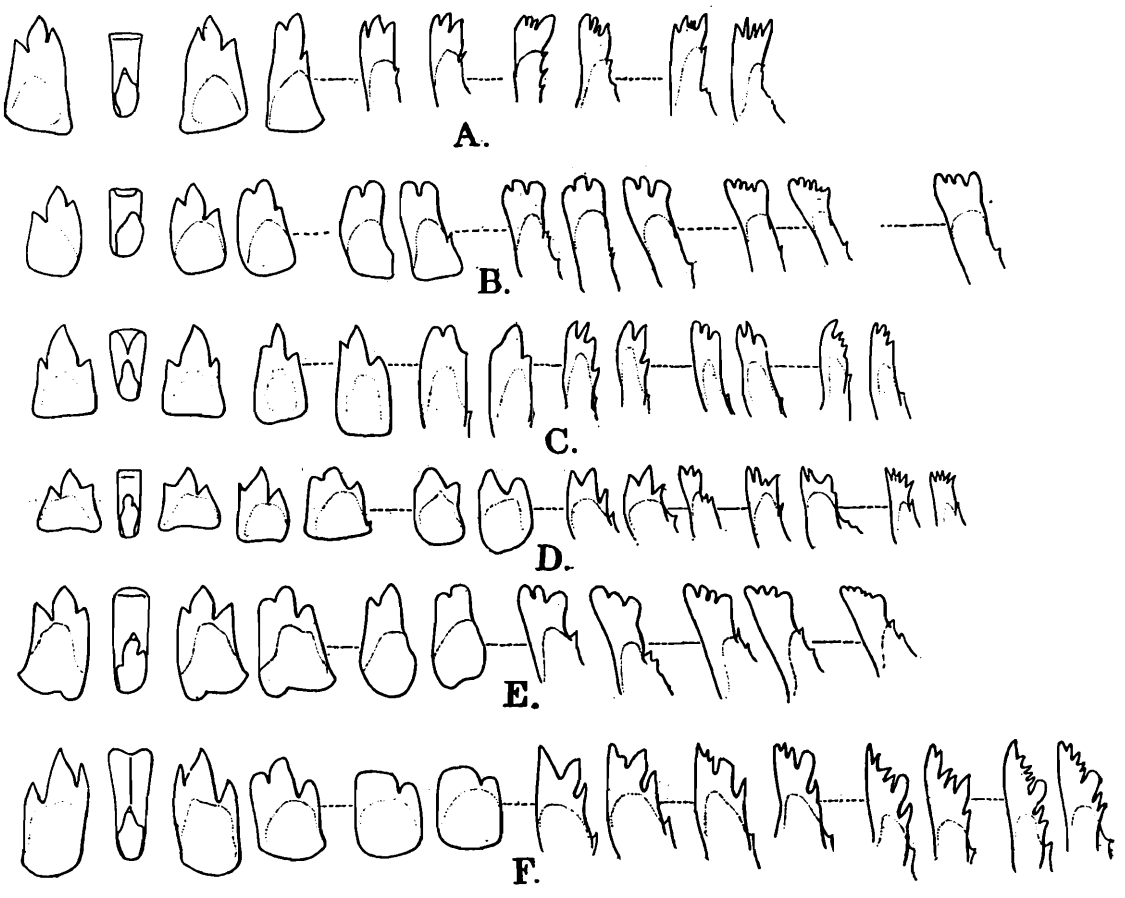

FIG. 6.—Radular teeth of *Limnaea* (× *ca.* 185).

A. Teeth of *Limnaea gedrosiana*, sp. nov from pond in garden in Quetta.
B. Teeth of same species from the reed-beds of the Hamun-i-Helmand.
C. Teeth of *L. gedrosiana* var. *rectilabrum*, var. nov from stones at edge of Kushdil Khan reservoir, Northern Baluchistan.
D. Teeth of same variety from small pool in desert near Nasratabad, Seistan.
E. Teeth of *L. bactriana*, Hutton, from irrigation channel, Nasratabad, Seistan.
F. Teeth of *L. iranica* from Persian Baluchistan.

Form from the Kerman district. The shell is small and thin, of a pale horny colour and (perhaps through age) opaque. The spire is short but prominent, acutely pointed and slightly oblique as a whole. It is considerably longer on the dorsal than on the ventral aspect of the shell, occupying about $\frac{1}{5}$ of the total length on the former and on the latter nearly $\frac{1}{8}$. The body-whorl is relatively large but not greatly inflated; its outlines are sinuous and it has considerable obliquity. The mouth of the shell is large

and oval; its main axis lies nearly parallel to but considerably outside that of the shell; it is hardly pointed posteriorly. The outer lip is sharp, broadly and fairly regularly arched; it extends far beyond the body-whorl posteriorly. The antero-internal angle is broadly rounded and a little expanded, the anterior border slightly flattened in its immediate vicinity. The columella is straight, its callus well-developed and broad but not coarse; it is slightly or not at all folded and is extended over the narrowly rimate umbilicus. The sculpture consists of fine, somewhat irregular longitudinal ridges with microscopic striae running parallel to them; the former are often developed only on the body-whorl.

Form from the Baluchistan desert. Our specimens from the Baluchistan desert were collected in December, 1918 by Mr. S. W Kemp at the edge of the Zanginawar lakes, 20 miles east of Nushki. These lakes are a series of small basins which retain the overflow from the Pishin river and contain water that is nearly fresh in winter and supports a luxuriant submerged vegetation. Mr. Kemp found only empty shells. These were abundant on the shore of the lakes one to two feet above the water-level.

The shells from Zanginawar only differ from those from the Kerman district in being rather smoother and distinctly narrower and in having the columellar callus narrower and slightly more folded. As may be seen from the figures on plate V, they vary somewhat in outline, and young shells are narrower and have the mouth less expanded than old ones.

Unfortunately we have no information about the radula or soft parts of either race of this species.

Measurements of Shells (in millimetres).

Specimens A—C are from Saidabad, S.W. of Kerman, S. Persia; specimens D—F from Zanginawar in the Baluchistan desert, 20 miles west of Nushki.

	A	B	C	D	E	F
Length	13·3	11·2	10·8	12·8	12·4	12·3
Breadth	10·0	7·0	7·0	7·7	7·6	7·9
Length of aperture	11·1	7·8	8·0	9·5	9·2	9·4
Breadth of aperture	7·0	5·0	5·0	6·4	6·1	6·5
Length of spire (dorsal)	2·5	2·7	2·0	2·1	2·3	2·4
Breadth of base of spire	2·5	2·5	2·5	2·0	2·4	2·6

It seems better, in the lack of anatomical information, not to dogmatize as to the precise relations of this form. There can, however, be little doubt that it belongs to the same group as *L. auricularia.*

Limnaea iranica, sp. nov.

(Pl. vii, fig. 1.)

1878. *Limnaea lagotis* var. *persica*, Nevill (*nec* Issel), *Hand List Moll. Ind. Mus.*, I, p. 237.

Shell. The shell is of small or moderate size, fairly thin, dull on the external surface, of a pale, dull opaque buff colour, orna-

mented with very fine longitudinal ridges and striae but without transverse striae. The shape is regularly, narrowly ovate, with the apex sharply pointed. The suture is not impressed and slightly oblique. The whorls, of which there are $4\frac{1}{2}$, increase gradually in size. The spire is prominent, but short, slightly oblique as a whole. It occupies a little less than $\frac{1}{4}$ of the total length in dorsal view and is only a little longer in ventral view. The body-whorl is ovate and not at all swollen, almost bilaterally symmetrical. In dorsal view the internal profile forms for the greater part of its length from the base of the spire a regular arc a little less than a semi-circle but is distinctly constricted in front of the internal anterior angle, which is broadly rounded and slightly produced. The mouth of the shell is long and narrowly pear-shaped, pointed and slightly introverted posteriorly. It runs backwards for about the length of the body-whorl. The outer lip is sharp, not at all thickened internally, broadly and regularly arched but not expanded. The columella is straight and slightly folded. Its callus, which is continuous with the outer lip posteriorly, is moderately developed. The anterior margin of the mouth is rounded and projects slightly. The columellar callus completely covers the very narrowly rimate or altogether closed umbilicus.

Measurements of shells (in millimetres).

Specimens A—C are from Persian Baluchistan (*Blanford*), specimens D—F from Magas in S. Persia (also *Blanford*).

	A	B	C	D	E	F
Length	18·3	14·5	15·3	14·4	13·4	10·3
Maximum breadth	11	9·1	9·1	8·4	7·5	6·2
Length of aperture	14·2	11·4	11·8	11·2	9·3	7·3
Breadth of aperture	9·5	8·1	7·3	7·2	6·4	5·1
Length of spire (dorsal)	3 6	2·9	3·3	3·4	2·4	2·6
Breadth of base of spire	4·2	3·5	3·7	3·5	3·5	2·9

Shells from the two localities only differ in size. Our specimens are those examined by Nevill.

Radula. We have extracted the radula from one of Blanford's specimens in which remains of the animal persisted. It is of the same type as that of *L. bactriana* but differs in several particulars. The base of the central tooth is distinctly bilobed. The three cusps of the inner lateral teeth are long and sharp, but those of the intermediate bicuspid teeth are short and blunt, the inner cusp being broadly truncate. The marginal teeth are somewhat remarkable, having the outer margin coarsely denticulate, one of the denticulations being often of a lobular nature. The dental formula is approximately 12.7.1.7.12.

Type-specimen. No. M11545/2, Zoological Survey of India (Ind Mus.) [Persian Baluchistan].

Localities. The only specimens we have seen are those collected by Dr. Blanford in Persian Baluchistan and at Magas in Southern Persia. There is a good series from each locality.

The position of this species is a little doubtful. The shell is in some respects intermediate between that of *L. peregra* (*ovata*) and that of *L. lagotis*. It resembles somewhat that of *L. intermedia* as figured by Kobelt in the new edition of Rossmässler's "Iconographie" (pl. 488, No. 2602), but the whorls increase more gradually in size and the mouth is broader.

Limnaea bactriana, Hutton.

(Pl. v, figs. 1, 2; pl. vii, fig. 6.)

1850. *Limnaea bactriana*, Hutton, *Journ. As. Soc. Bengal* XVIII (2), p. 656.

The shell is moderately small, thin, fragile, of a pale, dull brownish colour, polished when clean but coated with calcareous algae in most of the specimens examined. The surface is often irregularly decussated and always bears, at any rate on the body-whorl, prominent but narrow longitudinal ridges and corresponding striae set close together. No transverse striae can be detected with a lens. The sculpture is often concealed by the calcareous algal coat. The apex is acuminate but not very acute, the spire prominent, but occupying less than $\frac{1}{3}$ of the total length in dorsal view. The suture is impressed and moderately oblique. There are 4 or $4\frac{1}{2}$ whorls, which are neither swollen nor shouldered; those of the spire increase gradually in size and the penultimate whorl is relatively large. The body-whorl is large and of ovoid form; its inner outline is markedly sinuate and somewhat emarginate towards the anterior extremity, but the antero-internal angle is broadly rounded, the outer outline is evenly and not very strongly curved. The mouth is large but not expanded, extending backwards for more than $\frac{4}{5}$ the length of the body-whorl and being less than twice as long as broad; it is of symmetrical ovoid form, pointed posteriorly and with its main axis parallel to that of the shell. The outer lip is sharp and neither introverted nor expanded; it has a regular and considerable outward curvature and extends forwards considerably beyond the limits of the body-whorl. The peristome is continuous, the callus broad but thin, extending over the narrow but profoundly perforate umbilicus; the columella is distinctly folded.

As in many species of *Limnaea* the shell is dimorphic. We shall call the two forms (*a*) and (*b*) and describe the commoner (*a*) first.

(*a*) In this form the shell has a comparatively long spire, occupying nearly $\frac{1}{4}$ of its length in dorsal view. The first $3\frac{1}{2}$ whorls increase in size gradually, but the basal whorl of the spire is enlarged, the spiral is by no means uniform and the body-whorl comparatively narrow.

(*b*) The shell differs from that of (*a*) mainly on account of the fact that there is a distinct change in the direction of the spiral between the ultimate and penultimate whorls. The base of the spire is therefore concealed in the body-whorl so that its visible part

becomes comparativey short (slightly more than $\frac{1}{5}$) of the total length, while the body-whorl being more transverse appears broader and has a more expanded mouth, the posterior extremity of which is situated at a higher level on the shell.

Measurements of Shells (in millimetres).

	Type (*a*).	Type (*b*).	Young.
Length ..	18·0	16·0	7·4
Breadth	11·7	11·3	4·6
Length of aperture	11·0	10·8	4·8
Breadth ot aperture	6·5	6·3	1·7
Length of spire (dorsal view)	5·0	3·4	2·5
Breadth of base of spire (dorsal view)	3·5	3·2	2·0

The soft parts of the living animal have no noteworthy peculiarity. The foot and head are pale greenish yellow with minute whitish specks. The lower part of the mantle is black with large rounded yellowish spots; higher up the yellow predominates and the dark pigmentation is reduced to a delicate network.

The alimentary canal. The jaw is not strongly developed; the central piece is narrow and lunate, only its outer or marginal half is fully cornified and of a brown colour. The side pieces are feeble. The buccal mass is large and powerful, deeply rounded in lateral view. The salivary glands are smaller than in some species; they enter the alimentary canal just behind the buccal mass.

The radula is broad, its dental formula being approximately 18.7.1.7.18. The central tooth, which is comparatively large, has a distinctly tridentate cusp, which is very asymmetrical and is provided at the tip of the central denticulation with a minute thickened spine or tooth. The base of the tooth is elongate and only a little emarginate proximally. The lateral teeth are broad and tridentate; those on either side of the central tooth have the innermost denticulation subequal to the outermost and the central denticulation long and sharp. The outer lateral or intermediate teeth have two rather blunt cusps; the true marginals have from 3 to at least 7 very short and blunt denticulations, the outermost of which is the broadest. These denticulations are arranged in an almost straight transverse line.

The oesophagus is slender and elongate, marked on the surface with lines of dark pigment; it forms a well-defined double loop at about half its length between the buccal mass and the chyle stomach. This structure is short and by no means clearly differentiated externally. The lateral muscular masses of the gizzard are large but quite distinct in the middle line and slightly unequal in size; they extend very little over the true stomach, which is elongate and merges very gradually into the intestine

near the point at which the liver-duct enters the alimentary canal. The proximal part of the stomach is somewhat sacculated. The liver is large and the intestine rather stouter than in some species.

The *genitalia* are very like those of *L. chlamys*,[1] but the upper part of the male duct above the prostate, the lower part of the same duct and also the spermathecal duct are all considerably longer. Other apparent differences (the larger size of the female accessory glands and the more lobate form of the hermaphrodite gland) are probably due to the state of sexual activity in the specimens examined. The ovarian part of the hermaphrodite gland is particularly well developed. The prostate is spindle-shaped, but very small.

Habitat. This species was described from Quetta and was found in considerable abundance in an irrigation-channel leading to the garden of the British Consulate at Nasratabad (Seistan town) and also in pools on the parade-ground at the same place. In the channel the water was usually still, but it was allowed to flow freely every few days. It was always more or less turbid. The bottom was composed of stiff clay and supported a rather scanty growth of Characeae and of a narrow-leafed *Potamogeton*. In the pools, which had a similar bottom but contained a somewhat more luxuriant vegetation consisting chiefly of *Zannichellia palustris*, the water was extremely foul, being frequented by camels, donkeys and mules. The basins had been excavated in obtaining clay for bricks and the water had probably entered by percolation. Shells were also found subfossil in the banks of old water-channels near Nasratabad.

Habits. It is noteworthy that these molluscs, though living in water the surface of which was frequently frozen at the season at which they were observed, were in a state of sexual activity so far as the female organs were concerned. Egg-masses were abundant on the water-weeds. The adults seemed to feed chiefly on minute algae growing on the mud.

No difference was observed between those individuals from the dirty pools and those from the irrigation channel.

Affinities. Until the anatomy of the Asiatic Limnaeidae is better known some doubt must remain as to the affinities of this species. The shell resembles those of the group *L. lagotis*, but is more distinctly perforate. The structure of the spire somewhat resembles that of *L. lagotis* var. *subdisjuncta*,[2] Nevill, but the penultimate whorl is relatively large and the structure of the mouth is quite different. Hutton in his original description compared the shell to that of the young *L. chlamys*, Benson, and curiously enough, before we recognized the identity of our specimens, we did the same so far as the genitalia were concerned. There can be little doubt, therefore, that a relationship with the Indian

[1] Annandale and Prashad, *Rec. Ind. Mus.*, XVI, p. 143, fig. 4 (1919).

[2] *Sci. Res. Yarkand Miss. Mollusca*, p. 9 (1886). For figures see Weber, *Wiss. Ergeb. Reise. Thian-Schan*, Mollusken, pl. i, figs. *f-h* (*Ab. Bayer. Ak. Wiss. Math.-phys. Klasse*, XXVI, 1913).

species exists, but what precisely that relationship is still remains to be discovered.

We have compared our specimens from Seistan with one named by Hutton from the old collection of the Asiatic Society of Bengal This shell is stated to be from Kandahar, but Hutton records the species only from Quetta, which was in Afghanistan when he wrote. It is very possible that the locality is incorrect. The specimen is not mature and agrees very closely with the young shell figured by us on pl. vii.

Limnaea gedrosiana, sp. nov.

(Pl. vii, figs. 2–4.)

1850. *Limnaea peregra*, Hutton, *Journ As. Soc Bengal* (2) XVIII, p. 655.

This species, so far at any rate as the shell is concerned, closely resembles *L. iranica*, but differs in that the shell is smaller, thinner, paler in colour, smoother, less regular in outline, with a blunter apex, more oblique spiral and slightly more impressed suture. The colour is a faint greenish yellow, the shell is extremely fragile and when fresh quite transparent. There are $3\frac{1}{2}$ or 4 whorls. The spire is twice as long in dorsal as in ventral view, occupying at least $\frac{1}{4}$ of the length of the shell in the former. The curvature of the inner profile of the body-whorl is less convex and not so regular as in *L. iranica*, and this whorl as a whole is much less symmetrical. The mouth of the shell is ovate, pointed but not retroverted posteriorly. It is almost bilaterally symmetrical and narrower than in *L. iranica*; its main axis is parallel to that of the shell. Though relatively as long as in the preceding species, it only extends backwards for about $\frac{7}{9}$ the length of the body-whorl. The curvature of the outer lip is slightly flattened in adult shells. The anterior margin projects considerably beyond the body-whorl.

Measurements of Shells (*in millimetres*).

	Quetta			Lab-i-Baring.		
Length	11	9·1	7·1	7·5	8	7·8
Maximum breadth	6·3	5·6	4·6	4·1	4·1	4·6
Length of aperture	8·2	6·7	5·7	6·0	6	5·4
Breadth of aperture ..	5·4	4·1	3·6	3·8	3·6	3·3
Length of spire (dorsal)	2·3	1·7	1·4	1·3	1·4	1·4
Breadth of base of spire.	3·1	2·3	1·9	2·1	2·3	2·1

The living animal resembles that of *L. bactriana*, but the foot is perhaps rather smaller, the tentacles longer and more pointed and the colour pale.

The alimentary canal also resembles that of *L. bactriana*, but the muscular gizzard is more uniformly developed and more compact. It can be seen in the living animal through the shell as a globular shining mass.

The jaw and radula are of the same type as those of the species already discussed, and closely resemble those of *L. bactriana* in particular. They exhibit, however, great placticity and individual variability (see figures, p. 42). The marginals never have the peculiar form of those of *L. iranica*.

Genitalia. The genitalia are of the same type as those of *L. bactriana*, but have one important difference, viz. that whereas in that species the male and female parts of the system are approximately equal in length, in *L. gedrosiana* the vas deferens is greatly elongated, while the female ducts are short. This difference is not correlated with any difference in the position of the external sexual apertures, which in both species are situated almost on a level, but in *L. gedrosiana* the male duct is strongly convoluted.

Type-specimens. M. 11533/2, Zoological Survey of India (Ind. Mus.).

Localities. This species is common, as Hutton noted, in the Pishin district (Chaman) and at Kandahar. It also occurs in abundance at Quetta and in the Hamun-i-Helmand in Seistan.

Habits. *L. gedrosiana* can apparently live only amidst dense submerged vegetation. Hutton found it in brick tanks at Kandahar and in a small marsh at Chaman. Our specimens from Quetta were taken among weeds in a pool supplied by water from an underground source in the Residency gardens. The submerged vegetation in this pool was dense and the water, in November and January, perceptibly warmer than the air. In the Hamun this *Limnaea* occurs mainly amidst algae growing on the roots of *Phragmites* and also on *Potamogeton pectinatus* in small pools in the reed-beds.

Affinities. *L. gedrosiana* is apparently related to *L. peregra*, but differs in the blunter spire, more oblique spiral and longer mouth of its shell. We do not feel justified in uniting the two forms, and the shell differs considerably from that of any of the "varieties" from Central Asia ascribed to *L. peregra* by former authors.

Variation and plasticity. There is not much individual variation in shells from the same environment, except that correlated with age. Shells from Quetta, however, are larger and a little broader and have distinctly larger mouths than those from the Hamun. Moreover, their spire is distinctly shorter.

var. **rectilabrum**, nov.

(Pl. vi, figs. 1–6.)

This variety or phase differs from the *forma typica* so far as the shell is concerned mainly in having the outer lip distinctly flattened so that it slopes outwards in a straight line. Its margin is sometimes slightly turned inwards towards the aperture. The precise form of the mouth is, however, subject to considerable individual variation (see pl. vi). The radula does not differ more from that of the *forma typica* than that of the latter varies. The genitalia

are practically identical, but the vas deferens differs slightly in proportions.

This variety exhibits both individual variation and plasticity in a higher degree than *L. gedrosiana, s.s.* The shape of the mouth of the shell and of the whole body whorl differs considerably in individuals from the same environment, while individuals from one environment differ in having a narrower shell than those from another. The two localities from which we have examined fresh specimens are the Kushdil Khan reservoir, situated at an altitude of 5000 ft. in the hill-country of Baluchistan north of Quetta, and a small pool in the desert some miles south of Nasratabad in Seistan. The Kushdil Khan reservoir is a large body of clear shallow water artificially confined and liable to dry up in summer. In winter it contains at certain places a fairly dense submerged vegetation consisting of *Potamogeton pectinatus*, *Naias major*, etc. The pool near Nasratabad was quite a small one. At the time of our visit it was completely isolated in the desert, but in flood-time is evidently connected with a large backwater of one of the effluent channels of the Helmand. Its vegetation consisted in December of dead reeds and a scanty growth of broad-leaved *Potamogeton.*

Specimens from Kushdil Khan were much larger and as a rule considerably broader than those from Seistan (*cf.* figs. 1–3, 4–6 on pl. vi). All the shells from each locality belonged, though differing considerably, quite definitely to the variety.

At Kushdil Khan dead shells, some with remains of the animal, were collected in flood-drift on the edge of the reservoir, while a few individuals were found adhering to the lower surface of stones near the margins. The molluscs in the desert near Nasratabad were attached in large numbers to dead reed-stems and to the droppings of goats, flocks of which watered at the pool.

Measurements of Shells (in millimetres).

Specimens from A—C are from Kushdil Khan reservoir (Baluchistan), and specimens D—F from a small pool, some miles south of Nasratabad, Seistan.

	A	B	C	D	E	F
Length	15·1	13·4	14·5	12·2	11·1	9·8
Maximum breadth	9·6	8·1	8·8	7	6·8	5·4
Length of aperture	11·5	10	10·7	9·2	8·9	7·2
Breadth of aperture	8·1	6·4	7·6	5·6	5·5	4·4
Length of spire (dorsal)	3	2·7	3·4	2·8	2·2	1·8
Breadth of base of spire	3·8	3·4	3·5	3·1	2·7	2·8

Type-series. M 11534/2, Zoological Survey of India (Ind. Mus.).

Limnaea truncatula, Gray.

1850. *Limnaea truncatula,* Hutton, *Journ. As. Soc. Bengal* (2) XVIII, p. 656.

We have seen no specimens from Baluchistan or Seistan, but have examined a large series from different parts of the Western

Himalayas. These specimens provide evidence of much local plasticity, some agreeing with European shells, others having the form of the var. *longula* figured by von Martens in the report (in Russian) on the molluscs in Fedtschenko's *Reise in Turkestan* (vol. 1, pl. ii, fig. 26, 1874). Specimens from some Himalayan localities are much larger than those from others.

Hutton states that *L. truncatula* is common in the marshlands bordering the Helmand at Girishk and also in similar situations at the Kogrick Pass and at Quetta. The fact that it was not found at Quetta in winter is, therefore, interesting. The species seems more susceptible to drought and unfavourable conditions than most of the genus [1] and probably conceals itself in cold weather. Had it occurred at all commonly in Seistan, however, dead shells would probably have been recovered from the recent deposits examined at the edge of the Hamun and elsewhere. The presence of a liver-fluke of the genus *Fasciola* in the country does not necessarily imply that this mollusc is the intermediate host of the liver-fluke, for *L. truncatula* does not occur in North America and yet *Fasciola hepatica* is prevalent in some districts [2]; moreover, as Mr. Kemp points out in a note appended to this paper, the Seistan liver-fluke is not identical with the European one.

Limnaea hordeum, Mousson.

(Pl. vii, fig. 5.)

1874. *Limnaea hordeum*, Mousson, *Journ. Conchyl.* XXII, p. 42.

The shell is extremely small and rather thick, narrowly elongate but blunt at the apex. Our single specimen is bleached white and has a somewhat porcellaneous appearance. There are four whorls but the apical one is very small and projects little. The suture is impressed and very oblique, so that the spire is much shorter in the ventral than in the dorsal view. The third whorl is more than 3 times as long as the second and the body-whorl considerably longer than the spire. The mouth is small and rather narrow, almost straight and practically oval, being little contracted and not at all pointed posteriorly. The lip is somewhat expanded and has a thickened appearance due to a blunt ridge running round it a short distance inside the margin. The columella is slightly folded, its callus narrowly expanded over the rimate umbilicus. The callus is joined posteriorly to the outer lip. The surface of the shell is marked with faint longitudinal striae, which are regular and set close together.

We have compared our single specimen with two of Mousson's species from the edge of the river Euphrates and can find no difference. The species was originally described from that river. Our Mesopotamian specimens are from Nasariyeh. We obtained a single dead shell in a drift at the edge of a small pool in the

[1] Walton, *Parasitology* X, p. 243 (1917).
[2] Ward, *Fresh Water Biol. N. America*, p. 389 (1918).

desert some two miles south of Nasratabad in Seistan. The pool in flood-time is connected with a branch of the Helmand river. The following are the measurements (in millimetres) of our Persian specimen:—

Length	5
Maximum breadth	2·7
Length of aperture	2·2
Breadth of aperture	1·4

Family PLANORBIDAE.

The three species belonging to this family and known from Baluchistan and Seistan are all small and all occur commonly throughout Northern India and the adjacent countries. It is with some reluctance that we feel obliged to recognize the two groups represented by the three species as distinct genera, but they differ so much not only in shell but also in anatomy that no other course seems possible to us. We assign, therefore, two of the species (*Planorbis euphraticus*, Mousson and *P. convexiusculus*, Hutton) to the genus *Gyraulus*, Agassiz, and one (*Planorbis calathus*, Benson) to the still more distinct genus *Segmentina*, Fleming.

Genus **Gyraulus**, Agassiz.

1837. *Gyraulus*, Agassiz, *Nouv. Mem. Soc. Helv.* I (*fide* Preston, *Faun. Brit. Ind. Freshw. Moll.*, p. 118, 1915).

In this genus the shell is small, thin, flat, pale, translucent or transparent, without strong transverse ribs, with or without spiral epidermal cilia, with or without peripheral keel, with few whorls, with a simple lip, without teeth or partitions on the internal surface, with a dextral spiral. The radula has the central tooth bicuspid and the laterals bi- or tricuspid, the marginals with several sharp cusps. The edge of the mantle is not thickened. The vas deferens is continued distally into a narrow penis, which projects straight into an elongate bulbous chamber or penis-sheath and is armed at its termination with a well-developed horny stylet.

Type-species. Planorbis albus, Müller (Palaearctic).

There has been much confusion about the two species of this genus that occur in Baluchistan and Seistan, chiefly because conchologists have rarely seen specimens from the original localities. The correct names for these species are in our opinion *G. convexiusculus* (Hutton), of which *G. saigonensis*, Crosse and Fischer, is a synonym, and *G. euphraticus*, Mousson, to which Hutton and later Benson applied the preoccupied name *Planorbis compressus*.

Gyraulus convexiusculus (Hutton).

1850. *Planorbis convexiusculus*, Hutton, *Journ. As. Soc. Bengal* (2), XVIII, p. 657.

1864. *Planorbis saigonensis*, Crosse and Fischer, *Journ. de Conchyl.*, XII, p. 362, pl. xiii, fig. 7.

1876. *Planorbis convexiusculus*, Hanley and Theobald, *Conch. Ind.*, p. 48, pl. xcix, figs. 8–10.
1886. *Planorbis convexiusculus*, Clessin, *Die Fam. Limnaeiden* in Martini and Chemnitz's *Conch. Cab.* (ed. Küster), p. 127, pl. xvii, fig. 9.
1897. *Planorbis compressus*, v. Martens, *Süss-u. Brackw. Moll.* in Weber's, *Zool. Ergebn. Niederl. Ost.-Ind.* IV, p. 13, pl. i, figs. 17–22, pl. xii, figs. 7, 10.
1909. *Planorbis saigonensis*, Germain, *Rec. Ind. Mus.*, III, p. 117.
1918. *Planorbis saigonensis* (?), Annandale, *Rec. Ind. Mus.*, XIV, p. 112, pl. xi, fig. 12.
1919. *Planorbis, convexiusculus*, id., *Rec. Ind. Mus.*, XV, p. 166.

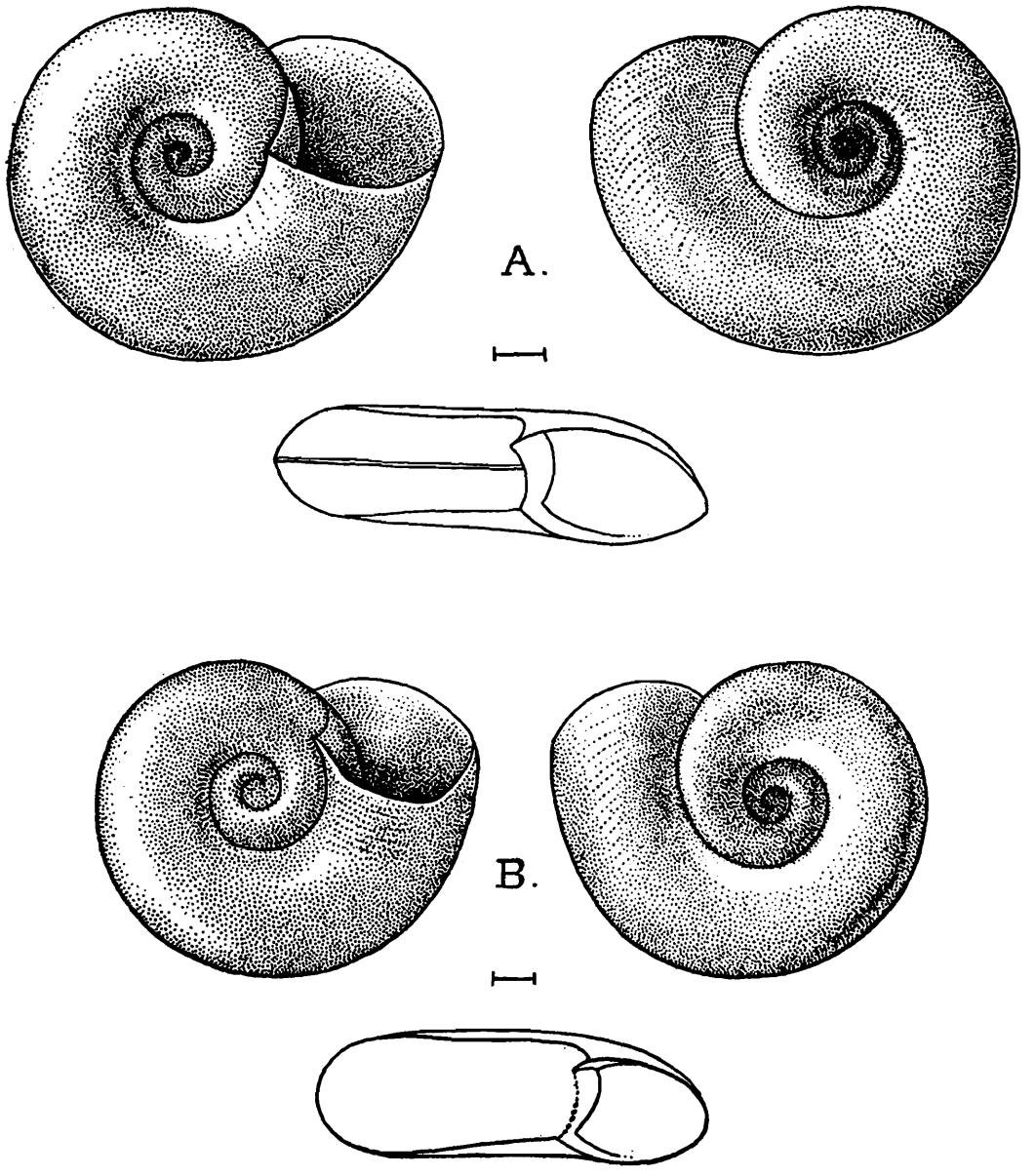

FIG. 7.—Shells of *Gyraulus* from pool in Residency garden, Quetta, Baluchistan.

A. *Gyraulus euphraticus*, Mousson. B. *G. convexiusculus*, Hutton.

This shell is apparently very like that of *G. albus*, the type-species of the genus, but the whorls are deeper. It rarely exceeds

5 mm. in maximum diameter. The figure of the mouth in *Conchologia Indica* is not very good, the upper margin being represented as too much elevated. Some variation, however, exists in this respect.

It is undoubtedly to *G. convexiusculus* and not to Hutton's *P. compressus* that Crosse and Fischer's *P. saigonensis* belongs. Specimens from Tibet identified by Germain (who had probably had access to the collections described by the latter authors) as *P. saigonensis* agree closely with shells from Quetta, one of the type-localities of Hutton's species.

The radula has approximately the dental formula 11.9.1.9.11. The two cusps of the central tooth are well developed and sharply pointed. The inner laterals have two stout, sharply pointed cusps, the outer laterals or transitional teeth three. The marginals have from four to six similar but more slender cusps. Von Martens' figure of the teeth is on too small a scale to show their structure clearly.

The genitalia (fig. 5 E, p. 40) belong to Simroth's [1] Typus III and closely resemble his figure of those of *Planorbis vortex* in general structure. All the ducts are, however, much shorter, the penis-sheath is larger and more elongate and the spermatheca smaller and also more elongate.

Planorbis convexiusculus is common with the succeeding species among weeds in water-channels and in pools in the reed-beds in Seistan, also in ponds near Quetta, where it occasionally occurs in large numbers on the muddy bottom of open water-channels. It is almost invariably found with *P. saigonensis*. Its geographical range extends from Lower Mesopotamia through Eastern Persia, Afghanistan and Northern India to Upper Burma, French Indo-China, China, Japan, and the Malay Archipelago.

Like many aquatic Pulmonates this species rises to the surface of the water in the evening and crawls shell-downwards on the surface film. It is, however, apparently unable to swim actively in this position as *G. euphraticus* does (*post.*, p. 56).

Gyraulus euphraticus, Mousson.

1834. *Planorbis compressus*, Hutton (*nec* Michaud), *Journ. As. Soc. Bengal* (2) III, p. 93.
1850. *Planorbis compressus. id., ibid.*, XVIII, p. 117.
1874. *Planorbis* (*Gyraulus*) *devians* var. *euphratica*, Mousson, *Journ. de Conchyl.* (3) XIV, p. 44.
1918. *Planorbis saigonensis*, Annandale, *Rec. Ind. Mus*, XV, p. 166.
1918. *Planorbis saigonensis, id., Mem. As. Soc., Bengal* VI, p. 304.

The shell of this species is so like that of *G. convexiusculus*, and the two are so frequently found together, that we would have felt inclined to regard them merely as dimorphic forms had it

[1] Simroth, "Mollusca (Weichtiere)" III, p. 502, fig. 165, pl. xxvi, figs. 4, 6 in Bronn's *Tier-Reich* (1912).

not been for certain differences in the radula and for the fact that the habits are to some extent distinct. The shell, as one of us has pointed out (*op. cit.*, 1918), differs from that of *G. convexiusculus* not only, as Hutton noted, in being more compressed and more strongly carinate, and having the lip and whorls of a slightly different shape, but also in being larger, more opaque and more coarsely and irregularly sculptured. The last whorl moreover as a rule deviates from the spiral of the upper whorls. These characters are to some extent variable, but the radula differs in having all the teeth narrower, all the laterals tricuspid and the marginals with smaller cusps. The genitalia have all the ducts longer than those of *L. convexiusculus* and the spermatheca much larger. Otherwise they are very similar.

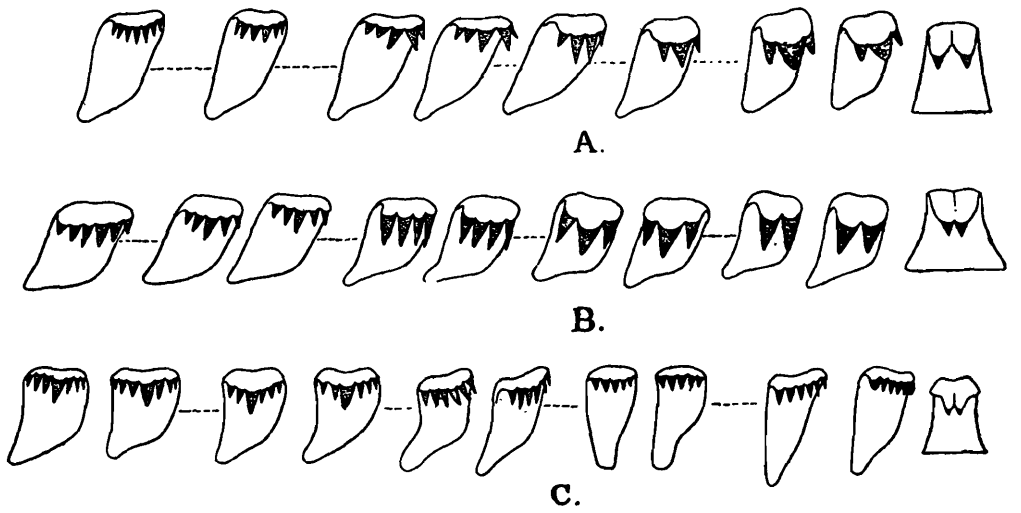

FIG. 8.—Radular teeth of Planorbidae.

A. Teeth of *Gyraulus euphraticus*, Mousson, from Quetta (× 708).
B. Teeth of *G. convexiusculus*, Hutton, from the same locality (× 900).
C. Teeth of *Segmentina calathus* (Benson) from swamp near Gurdaspur, Punjab (very highly magnified).

Germain[1] regards Hutton's *Planorbis compressus* as synonymous with *P. saigonensis*, Crosse and Fischer, but specimens from Northern India have the sculpture coarser and more irregular, the last whorl more oblique, the mouth larger and more oblique and the inner whorls more concave on the lower surface than is shown of *G. saigonensis* in Crosse and Fischer's[2] original figure, with which specimens agree. Specimens of the carinate form from Quetta, however, agree closely with shells of Mousson's *G. devians* var. *euphratica* recently collected by Captain C. L. Boulenger in Mesopotamia. The species would, therefore, appear to be essentially a Palaearctic one, but there has been much confusion as to

[1] *Rec. Ind. Mus.*, III, p. 117.
[2] Crosse and Fischer, *Journ. de Conchyliologie*, XI, p. 362, pl. xiii, fig. 7.

its real distribution. It certainly extends from Mesopotamia to the Kiangsu Province of China.

The habits differ from those of *G. convexiusculus* in that the animal swims actively on the surface in the evening. This we recently observed at Chakradharpur in Chota Nagpur, and we have been able to confirm the observation in Calcutta. While floating shell-downwards like other species of the family with its foot applied to the surface film, it moves forward rapidly in a jerky manner by repeated strokes of its shell in the water. The sole of the foot adheres to the surface-film and the shell is raised almost to a horizontal position with its major axis parallel to but well below the film. It is then rapidly depressed, so that momentarily the axis forms almost a right angle with the surface. After this downward stroke it is rapidly raised again to a horizontal position, and the animal is propelled forwards a little obliquely. The manoeuvre is frequently repeated, each time with a jerk, leverage being provided by the friction between the sole of the foot and the surface-film. Doubtless the flattened, carinate form of the shell is of advantage in its use as an oar, and probably all species with this character behave in the same way. The bacterial "velum", noted in the Burmese species *G. velifer*,[1] is commonly present in *G. euphraticus* also.

Genus **Segmentina**, Fleming.

1828. *Segmentina*, Fleming, *Hist. Brit. Anim.*, p. 270.

This genus consists like *Gyraulus* of small or minute, thin-shelled species, but the whorls are as a rule of a different form, convex above and flattened below and the shell is characterized by the production at intervals on the inner surface of the main whorl of curious opaque, white, transverse teeth or ridges of an enamel-like substance Correlated doubtless with the presence of these is the fact that the edge of the mantle is thickened. The radula differs from that of *Gyraulus* in having the teeth narrower and with smaller cusps and all the lateral multicuspid. The genitalia are also of a different type in that the penis, though produced into the penis-sheath, is directed into it from one side and is not provided with a horny stylet.

Type-species. Planorbis nitidus, Müller (Palaearctic).

Segmentina calathus (Benson).

1850. *Planorbis calathus*, Benson, *Ann. Mag. Nat. Hist.* (2) V, p. 348.
1876. *Planorbis calathus*, Hanley and Theobald, *op. cit.*, pl. xxix, figs. 4-6.
1918. *Planorbis calathus*, Annandale, *Rec. Ind. Mus.* XIV, p. 113.

The shell is very much like that of the type-species of the genus (*Planorbis nitidus*, Müller), to which it apparently bears

[1] Annandale, *Rec. Ind. Mus*, XIV, p. 112, pl. xi, figs. 7–11.

much the same relation as *Gyraulus convexiusculus* does to *G. albus*. The radula has approximately the formula 13.10.1.10.13. The teeth are rather small. The terminal part of the central tooth is distinctly bilobed. The inner laterals have six small, sharp cusps, the other teeth of the same series five. The inner marginals have six cusps very similar to those of the inner laterals, while the outer marginals have seven cusps, the central cusp being considerably larger than the others.

Our material is not well preserved for anatomical investigations, but in a specimen from the Punjab the terminal part of the male duct belongs to Simroth's Typus II. The blind sac-like appendages shown in his diagram (*op. cit.*, p. 502, fig. 165) are however, very poorly developed.

The species is common in swamps in Northern India, but somewhat local in its distribution. It is recorded from several places in the Himalayas, Bengal, Assam, Burma, Ceylon and Siam. One of us recently found it to be common in a swamp near Peshawar on the North-West Frontier of India and also obtained a specimen in a similar situation at Gurdaspur in the Punjab. Two dead and whitened shells were found at the edge of a pool in the desert near Nasratabad, Seistan. The shells are very small, but otherwise fairly typical.

CLASS **LAMELLIBRANCHIA** (=PELECYPODA).

This class is represented in our collections from Seistan and Baluchistan by large series of specimens of two species, *Corbicula fluminalis* (Müller) and *Lamellidens marginalis* (Lamarck). Hutton (*Journ. As. Soc. Bengal*, XVIII, p. 659: 1850) has described under the name *Pisidium paludosum* a third species from Chaman, now on the Afghan frontier of Northern Afghanistan, but we have seen no shells of this form. It may be a young *Corbicula*.

Corbicula fluminalis, which also occurs in ponds and streams at Quetta, and the *Unio* are both so abundant in Seistan, both recent and subfossil, that their shells are a feature of the country. They are found lying on the surface, wherever the land is occasionally flooded, in thousands and the banks of ancient streams and lakes are full of the shells of *Corbicula*. This is the case at many places now completely desert. Though the shells are frequently bleached and sometimes wind-worn and sand-eroded, they are usually in a remarkably perfect condition.

Family CYRENIDAE.

Genus **Corbicula**, Megerb.

This genus provides many difficult problems in taxonomy, increased by the fact that there is no recent, well-illustrated monograph. Undoubtedly many of the so called species now generally accepted will have to retire into the synonymy of others.

Corbicula fluminalis (Müller).

(Pl. viii, figs. 1–6.)

1774. *Tellina fluminalis*, Müller, *Verm. terr. et fluv. Hist.* II, p. 205.
1818. *Cyrena cor*, Lamarck, *Anim. sans. Vert.* V, p. 552.
1854. *Cyrena crassula*, Mousson, Bellardi's *Cat.*, p. 54
1864. *Corbicula cor*, Prime, *Ann. Lyc. Nat. Hist. N. York*, VIII, p 7, fig. 8.
1866. *Corbicula crassula, id., ibid.*, p. 216, figs. 44, 45.
1883. *Corbicula fluminalis+C. crassula*, Locard, *Arch. Mus. Hist. Nat. Lyon* III, pp. 222, 256, 258, pl. xxii, figs. 17, 18, 25, 26.
1913. *Corbicula fluminalis*, with var. *cor*, Germain, *Bull. Mus. Hist. Nat.* (Paris), p. 472.

The species is a very variable and plastic one and has a very wide geographical range in Africa and Asia. It was originally described from the Euphrates. We have examined a large series of fresh and subfossil shells from Seistan, the Afghan desert and Northern Baluchistan. Those from the Afghan desert were collected by the Seistan Boundary Commission of 1902–1903. Several small shells were also obtained in a spring of distinctly brackish water at Saindak in the west of the Baluchistan desert. In most of the series comprised in this collection, including those of fresh shells from the Hamun-i-Helmand, the specimens can be separated easily enough into two groups, one agreeing well enough with the majority of shells from the Euphrates, the other with the breadth proportionately narrower and the umbonal region more prominent. The former form is undoubtedly the true *Tellina fluminalis* of Müller, while the latter agrees closely with Prime's figures of *Corbicula cor* (Lamarck). In one large series from the desert on the banks of the Helmand in Afghan territory some of the shells are still narrower and come very near the same author's figures of *Corbicula crassula*, Mousson; while in several series shells intermediate between *C. fluminalis* and *C. cor*, *C. cor* and *C. crassula* are readily selected. *C. cor* and *C. crassula* may, therefore, be recognized at most as varieties, if this be convenient, but not as distinct species.

All the shells we have examined from Mesopotamia, Seistan or Persia are small, and the species in Asia Minor (in which also, however, it is (*fide* Locard) plastic in size) apparently attains larger dimensions in favourable circumstances. The largest fresh specimens we obtained in Seistan is a single valve 27·5 mm. broad by 24·5 mm. high. It exhibits an interesting abnormality in the hinge, in which only one, the central, cardinal tooth is developed. The colour of the periostracum varies from bright green to black; that of the inner surface is violet. Mesopotamian shells are often decorated with broad, whitish, transverse bars externally.

The species commonly hides itself in mud or sand in winter. We found very few living examples in Seistan, in spite of the abundance of fresh shells everywhere. Several living individuals were, however, dug from mud at the bottom of small pools in the Randa stream near Jellalabad, about 12 miles north of Nasratabad, in November.

Family UNIONIDAE.

Genus **Lamellidens**, Simpson.

1900. *Lamellidens*, Simpson, *Proc. Nat. Mus.* (*Washington*), XXII, p. 854.
1911. *Lamellidens*, Ortmann, *Nautilus*, XXIV, p, 106.
1918. *Lamellidens*, Prashad, *Rec. Ind. Mus.* XV, p. 145.
1919. *Lamellidens, id., ibid.*, XVI, p. 293, fig. 4.

The occurrence of this genus in Seistan proves the existence of a distinct Indian element in the fauna.

Lamellidens marginalis, Lamarck.

Subsp. **rhadinaeus**, nov.

(Pl. iii, figs. 9, 10; pl. viii, figs. 7–11.)

Shells from Seistan only differ from those of the *forma typica* from Bengal in a few particulars, but the differences are constant in a large series. In shape the shell is somewhat variable, but is close to that of the var. *corrianus*, Lea, being more transverse and having the upper margin straighter than that of the *forma typica*. In this respect it is intermediate between the two varieties. It is slightly more tumid than either and in old shells one or other of the valves is as a rule bent outwards slightly at the point at which the foot emerges, causing the shell to gape at this point. The sculpture of the young shells is finer and sharper than in the common Indian varieties. The teeth of the hinge are more prominent than in either form, the pseudocardinals stouter and the laterals more bent. In their stoutness the teeth approach those of the species or variety *L. jenkinsonianus* (Benson) of Bengal and Assam.

The older part of the shell is pale cream-colour or silver-grey externally. This usually deepens, as the shell grows, to chestnut, and sometimes even to black. Some shells, however, are pale greenish; there is usually at least one pale yellowish zone on the darker region, and the margin is sometimes pale. The nacre is bluish white and has a china-like lustre with very little iridescence.

Two phases can be distinguished, the difference being visible even in very young shells.

Phase A.—The shell is of considerable size and thickness, with the growth-lines strongly developed, the epidermis of the lower part dark and the hinge-teeth unusually stout and prominent, approaching those of some species of *Unio* in development.

Phase B.—The shell is smaller, thinner, less inflated and paler in colour and the hinge-teeth are less stout and not so prominent.

The young shell seems to be slightly more elongate in phase B than in phase A and is distinctly smoother in the former. It does not differ in essential characters from that of the typical form of the species, but has the sculpture less well developed; it is rather shorter in proportion than that of the var. *corrianus*. Its sculpture is very well preserved even in old shells, the glochidial shell often remaining as a minute tubercle. When about 25 mm. long the shell has a fairly prominent dorsal " wing " and is thin, almost translucent and of a greyish colour.

Measurements of Shells (in millimetres).

Specimens A—C belong to phase A : specimens D—F to phase B.

	A	B	C	D	E	F
Length	97·8	90	90·2	71·3	73·6	51·6
Height	55·5	49·9	47·8	38·4	39·1	28·3
Thickness	37·4	33·4	33·3	25	25·3	16·1

Lamellidens marginalis subsp. *rhadinaeus* is common all over

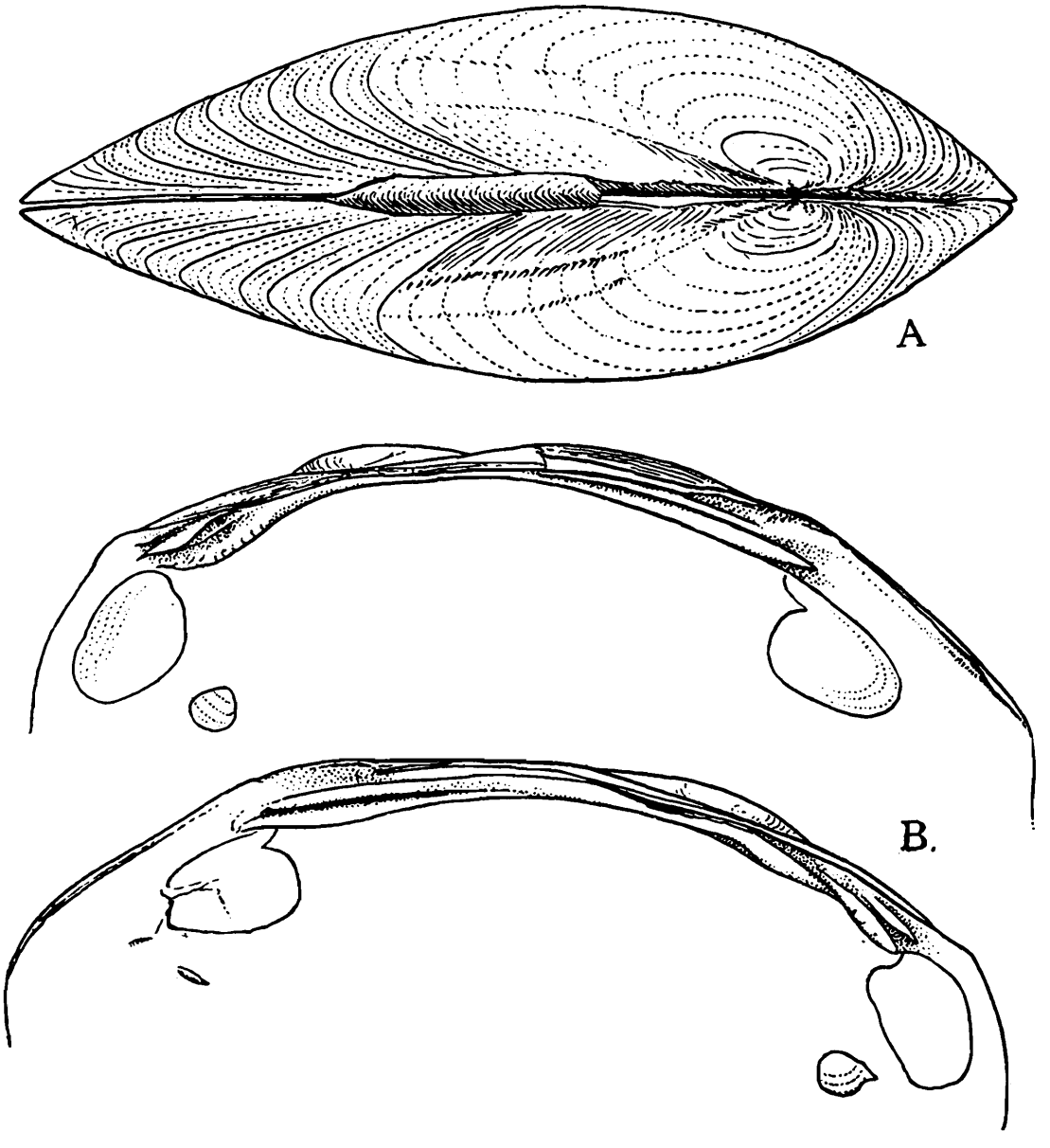

FIG. 9.—Shells *Lamellidens marginalis rhadinaeus*, subsp. nov. (natural size).

A. Dorsal view of type-specimen from a backwater of an effluent of the Helmand near Nasratabad, Seistan.

B. Hinges and scars of the same specimen.

Seistan and broken shells from the Afghan desert evidently belong to the same form. It appears to be quite distinct from the var. *candaharica*, with specimens of which we have compared our series. The range of the species, which is a very plastic one, is more

extensive than Simpson (*op. cit.*, p. 855) stated, extending from the mountains of Afghanistan to Ceylon and from Seistan to Burma, possibly even to Java and South China.

Dead shells were found in very large numbers at the following places in Seistan:—at the edge of the Hamun near Lab-i-Baring, in pools in the desert near Nasratabad, in the bed of Randa stream near Jellalabad about twelve miles to the north and in a large backwater of an effluent of the Helmand some miles to the south-east of the capital. They were also observed on the surface and buried in the stiff clay of open plains near Jellalabad which are periodically flooded. Specimens from still water, including the Hamun, belong to phase B, those from water directly connected with larger streams to phase A.

All these shells were in a remarkably good state of preservation, and their surface was not at all eroded. In many instances the valves adhered tightly together and the molluscs had every appearance of being alive. Indeed, many of them were brought us as containing the animal by herdsmen at Lab-i-Baring, and the people were evidently surprised when we opened them and found only mud inside. It is probable that the animal burrows deep into the mud at the approach of winter and in this connection the gape in the lower margin of the shell of many old individuals is of considerable interest, indicating that the foot is particularly large and powerful.

The shells give an indication of the age which the form habitually reaches, but this indication is open to two interpretations. On all the larger shells examined three very distinct regions can be distinguished. Round the umbo there is a region about 25 mm. wide by 13 mm. high in a large shell. The sculpture of this region, though clear-cut, is almost microscopic. It includes the nodulose and sloping ridges characteristic of the species, and also numerous (about 16) concentric longitudinal striae, each of which is compound. This region has a smooth appearance as a whole and is always of a pale colour. The next region is a broad band about 60 mm. broad by 24 mm. high in a large shell. Its general appearance is similar to the first region, but the epidermis becomes darker towards the lower margin, and it bears about the same number of compound striae. The third or outer region is about 30 mm. deep and occupies the full width of the shell. It has a much rougher appearance than the other two and bears four to six bands or groups of compound striae separated by smooth grooves. We are able to state definitely that the first region represents the growth of more than a year From the situations in which fresh shells are found in winter, where we may confidently believe they occur living in the flood-season, it is clear that the animal commonly undergoes a fairly prolonged period of hibernation, and in all probability it breeds when the floods are at their height in April or May. We found several shells in November that correspond precisely with the first region in the adult shells, and one of them still contained remains of the soft parts. Allowing for the period of free larval

and parasitic life, it is improbable that the shell would grow 25 mm. in one season, and we take it that these young shells represent the growth of something more than a year, probably about eighteen months. The second region probably represents that of one year more, but does the third region correspond to the growth of one year or of six? Probably of one, to judge from the striae on a large series of shells. If this be so, *Lamellidens marginalis rhadinaeus* probably lives as a rule for a little over three years and then dies directly or indirectly of old age. The great majority of the shells collected must, if our surmises are correct, have been of this age, and the animals through weakness or for some other reason, have failed to burrow down to the subsoil water through the very stiff clay on the bottom of the basins in which they lived, when the water began to dry up with the retreat of the floods.

NOTE ON THE LIVER-FLUKE OF SHEEP IN SEISTAN.

By STANLEY KEMP, B.A.

When in Seistan we were informed that both sheep and cattle are frequently infected by a liver-fluke which causes a heavy mortality at certain places in the early summer of each year. On enquiry we learnt that the Seistanis associated this parasite with the fact that when the annual floods recede the flocks are grazed on the peculiar vegetation that springs up on recently inundated land.

I was able (in December) to examine the livers of three sheep, the bile-ducts of two of which contained flukes of the genus *Fasciola*, s.s. In one of the livers the worms were unfortunately dead and in a putrefying condition. The other contained eleven specimens, all of which were alive.

Unfortunately the literature on this genus is poorly represented in our Calcutta libraries and several important American memoirs on the subject are lacking. Notwithstanding this fact, however, there appears to be little doubt as to the specific identity of the Seistan form, for most of our specimens agree in every particular except size with the excellent figures of Cobbold's *Fasciola gigantea*, reproduced from Looss by Stevens in "*The Animal Parasites of Man* (London, 1916).

The chief characters by which this species is distinguished from *Fasciola hepatica* are the following :—

(i) The form is generally much more elongate and band-like instead of leaf-shaped, the tapering of the posterior extremity being confined to a very small area.

(ii) The cephalic cone is considerably shorter in proportion to the length of the whole organism.

(iii) The posterior sucker is larger and more prominent and is situated on a line with the junction of the cephalic cone and body, instead of well behind the cone.

(iv) The main lateral diverticula of the gut are considerably more numerous.
(v) The posterior testis does not extend to the posterior third of the body.
(vi) The eggs are larger.

In all these characters except the first our Persian specimens are constant. In eight of the specimens the length varies from 38 to 43 mm. and the breadth from 9 to 11 mm., the proportion of length to breadth being from 3·5 to 4·4. Two specimens are damaged. The remaining individual is abnormal in form; its length is 28 mm., its breadth 12 mm. and it is leaf-shaped in outline. In structural characters, however, it is identical with other individuals from the same sheep.

The eggs are approximately 156 to 173 μ in length and 86 to 95 μ in breadth.

The small size of the specimens may possibly be due to the fact that they were examined before they had attained their full dimensions, though they were sexually mature. We were, indeed, informed by the sergeant in charge of the slaughtering of sheep for the troops at Nasratabad that he had noticed very much larger individuals later in the year.

In my examination of freshwater snails in Seistan I found no cercariae that could be associated with *Fasciola*, probably because the incidence of the parasite in the molluscan host is seasonal. Judging, however, from the abundance of shells in the soil of inundated land at the edge of the Hamun, the intermediate host is probably *Limnaea gedrosiana*, Annandale and Prashad. As this mollusc is also common in the hill-country of Baluchistan it would be interesting to know whether the fluke occurs there also.

So far as we are aware *F gigantea* has not hitherto been recorded from Asia. Looss cites *F. angusta* (Railliet) and *F. aegyptiaca*, Looss, as synonyms[1] and states that the species is widely distributed in Northern Africa, including Egypt. It is said to have occurred accidentally in man in South America.

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[1] Looss, *Zool. Jahrb., Syst.*, XVI, p. 783 (1902).

EXPLANATION OF PLATE III.

FRESHWATER MOLLUSCA OF BALUCHISTAN AND SEISTAN.

The natural size of the shells is indicated by vertical or transverse lines.

Amnicola (Alocinma) sistanica, subgen. et sp. nov.

FIGS. 1–4.—Shells from Seistan, illustrating variations in form.

FIG. 5.—Operculum as seen from within (× about 10).

Melanoides pyramis var. **flavida** (Nevill).

FIG. 6.—Animal removed from shell (× 2).

Melanoides scabra var. **elegans** (Hutton).

FIG. 7.—Shell from Sunderbans, Bengal.

Melanopsis deserticola, sp. nov.

FIG. 8.—Type-specimen from Kaindak, Persian Baluchistan.

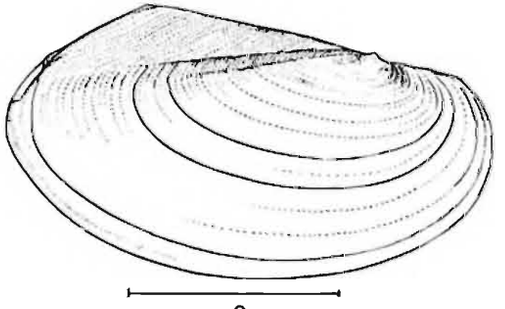
Lamellidens marginalis, subsp. **rhadinaeus**, subsp. nov.

FIG. 9.—Young shell of phase B from a pool in the desert near Nasratabad, Seistan.

,, 10.—Young shell of phase A from the Hamun-i-Helmand near Lab-i-Baring, Seistan.

Lamellidens marginalis var. **corrianus** (Lea).

FIG. 11.—Young shell from a pond on the Calcutta Maidan.



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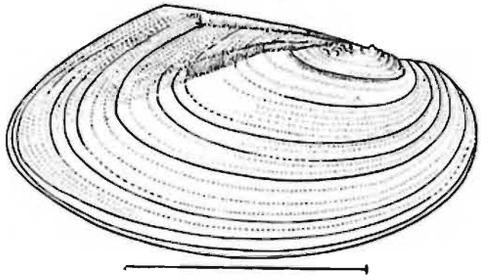

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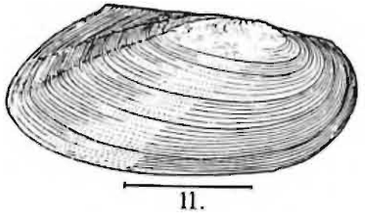

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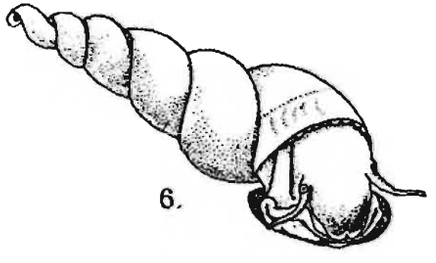

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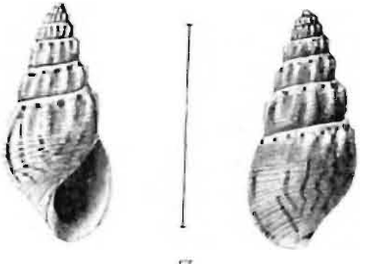

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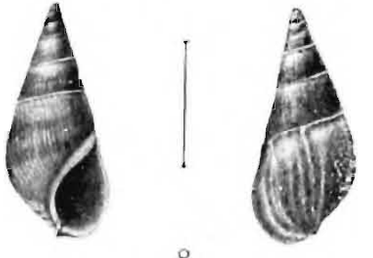

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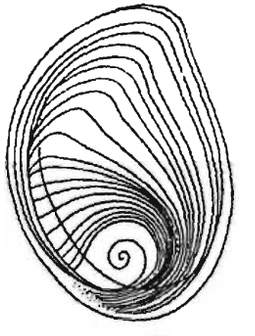

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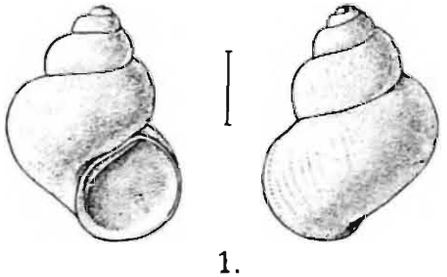

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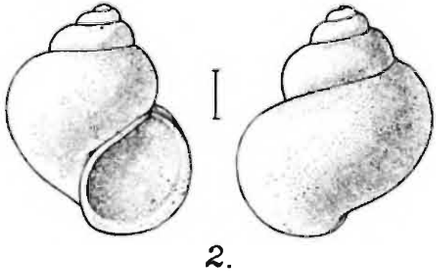

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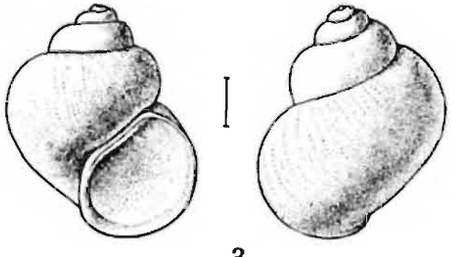

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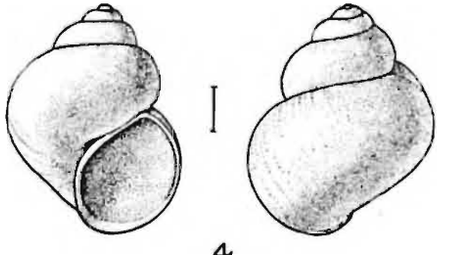


4.

D. Bagchi & A. Chowdhary del.

MOLLUSCA OF BALUCHISTAN & SEISTAN.

EXPLANATION OF PLATE IV

MELANOIDES TUBERCULATA (MÜLLER), M. PYRAMIS (HUTTON) AND M. TIGRINA (HUTTON).

The natural length of shells is indicated by vertical lines.

Melanoides tuberculata (Müller).

FIG. 1.—Shell from the Hosansagar tank, Secunderabad, Deccan.

Melanoides tigrina (Hutton).

FIG. 2.—Shell from Quetta, Baluchistan.

Melanoides pyramis (Hutton).

FIG. 3.—Dead shell from Quetta, Baluchistan.

Melanoides pyramis var. **leopardina**, var. nov.

FIG. 4.—Shell from Poona, Bombay Presidency.

Melanoides pyramis var. **luteomarginata** (Nevill).

FIG. 5.—Shell from type-series; Persian Baluchistan.

Melanoides pyramis var. **flavida** (Nevill).

FIG. 6.—Shell from a spring at Hurmuk on the Perso-Afghan-Baluch frontier.

Melanoides pyramis var. **puteicola**, var. nov.

FIGS. 7, 8.—Shell from type-series from a well at Ferozepore, Punjab.

INDIAN AND PERSIAN SPECIES OF *MELANOIDES*.

A. C. Chowdhary, del.

EXPLANATION OF PLATE V

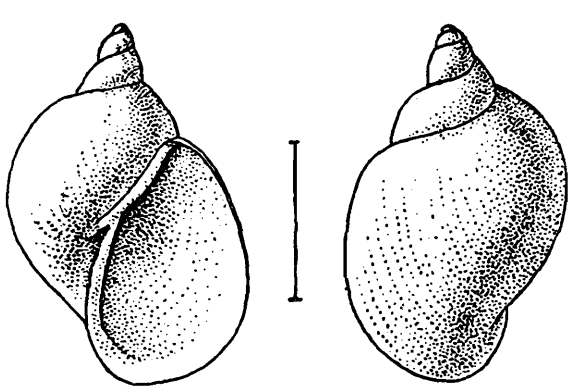
LIMNAEAE OF BALUCHISTAN AND SEISTAN.

Limnaea bactriana, Hutton.

FIGS. 1, 2.—Shells from a water-channel, Nasratabad, Seistan.

Limnaea persica, Issel.

FIGS. 3, 4.—Shells from near Kerman, Eastern Persia.
,, 5, 6.—Shells from the Zanginawar Lakes in the Baluchistan desert near Nushki.



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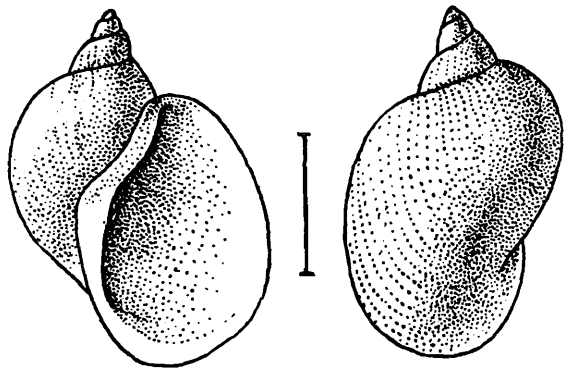

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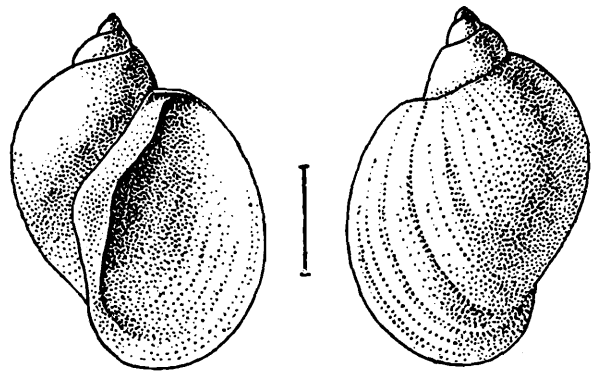

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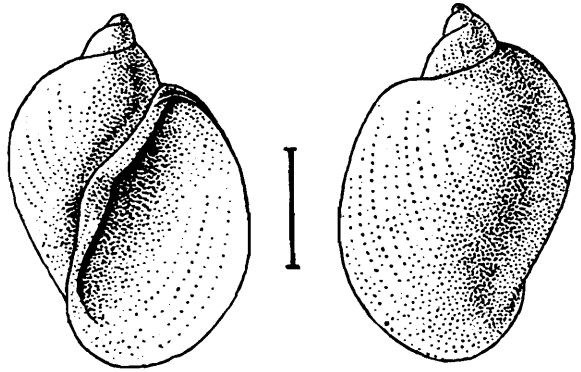

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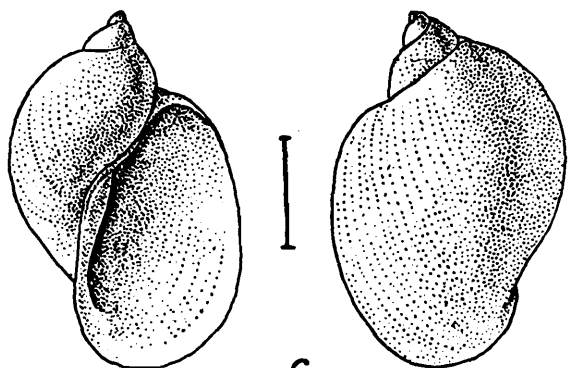

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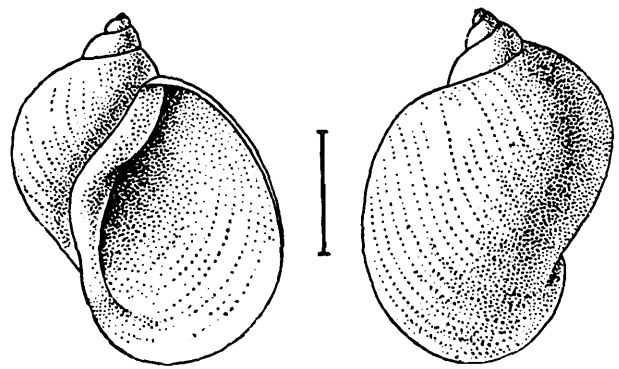

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A. Chowdhary del.

LIMNAEIDAE OF SEISTAN AND BALUCHISTAN.

Plate V

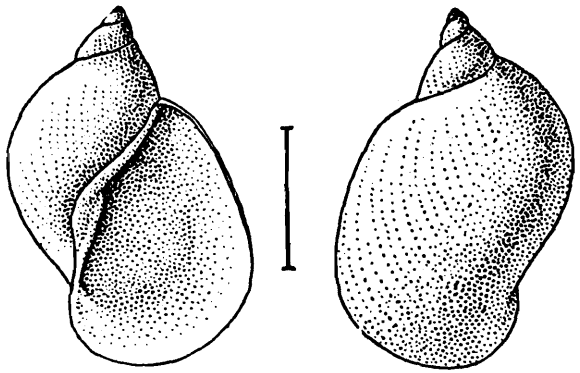
EXPLANATION OF PLATE VI.

Limnaea gedrosiana var. **rectilabrum**, var. nov.

FIGS. 1–3.—Shells from the Kushdil Khan reservoir, Pishin District, Northern Baluchistan.

,, 4, 6.—Shells from a pool in the desert near Nasratabad, Seistan.

FIG. 5.—Young shell from the edge of a backwater of a large water-channel in the same district.



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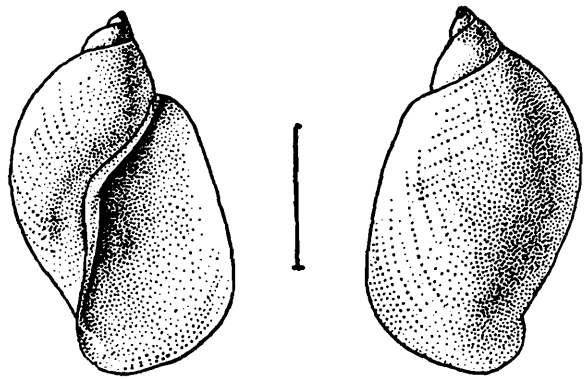

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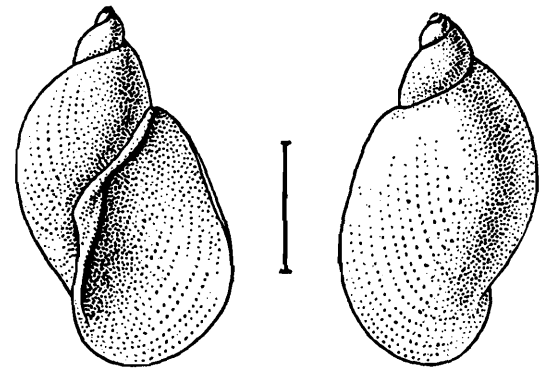

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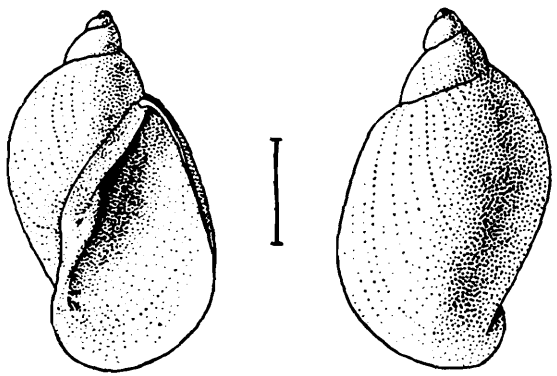

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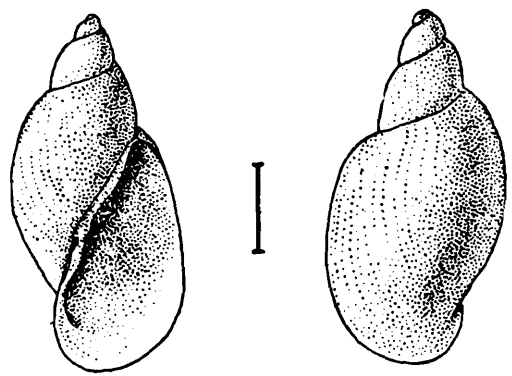

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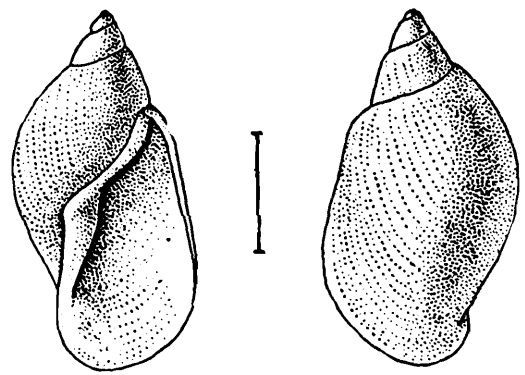

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A. Chowdhary del.

LIMNAEIDAE OF SEISTAN AND BALUCHISTAN.

EXPLANATION OF PLATE VII.

LIMNAEAE OF BALUCHISTAN AND SEISTAN.

Limnaea iranica, sp. nov.

FIG. 1.—Type-specimen from Persian Baluchistan.

Limnaea gedrosiana, sp. nov.

FIG. 2.—Shell (type-series) from a pond in the Residency garden, Quetta, Baluchistan.

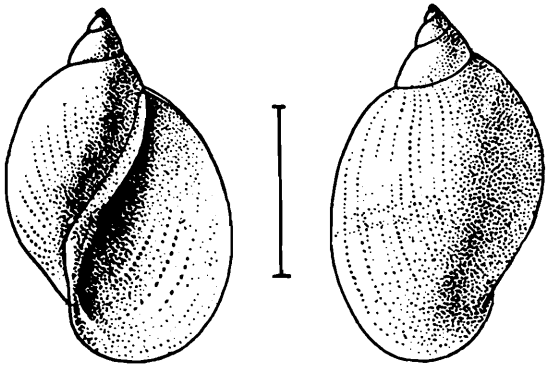
FIGS. 3, 4.—Shells from the reed-beds of the Hamun-i-Helmand near Lab-i-Baring.

Limnaea hordeum, Mousson.

FIG. 5.—Shell (? subfossil) from the desert near Nasratabad, Seistan.

Limnaea bactriana, Hutton.

FIG. 6.—Young shell from the desert near Nasratabad.



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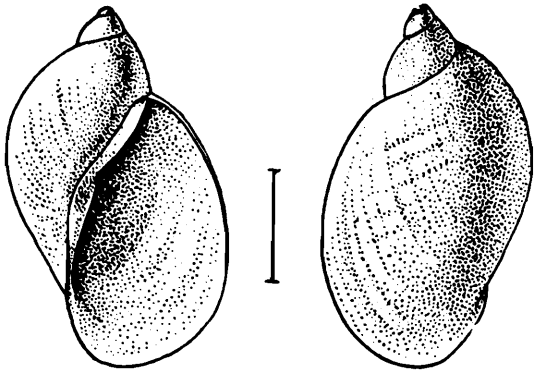

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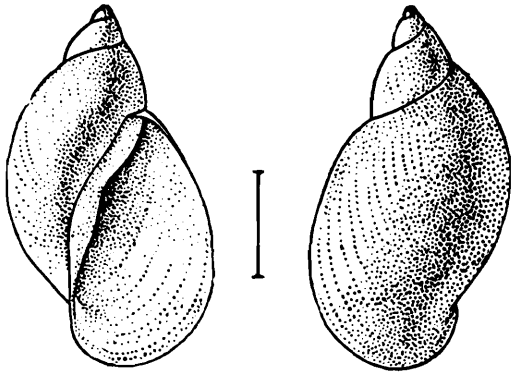

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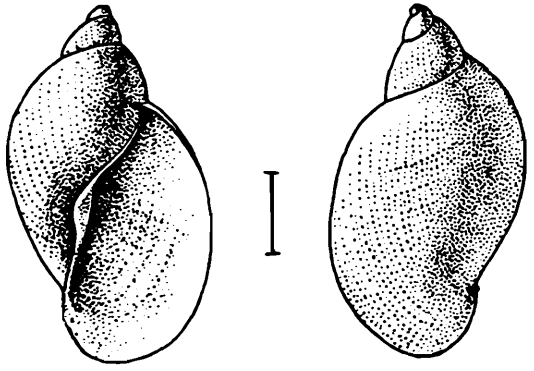

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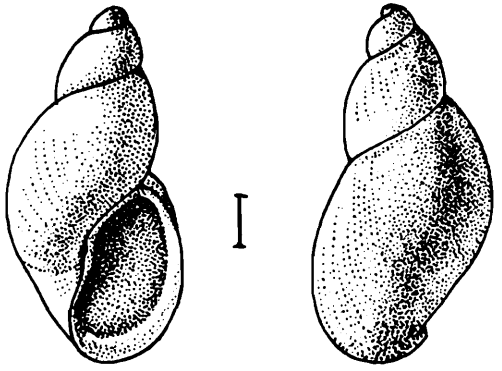

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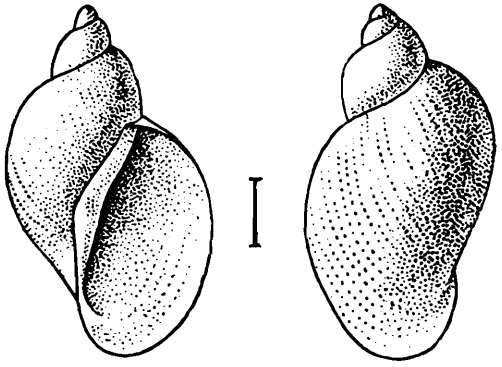

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A. Chowdhary del.

LIMNAEIDAE OF SEISTAN AND BALUCHISTAN.

EXPLANATION OF PLATE VIII.

LAMELLIBRANCH MOLLUSCS OF SEISTAN AND THE AFGHAN DESERT.

Corbicula fluminalis (Müller).

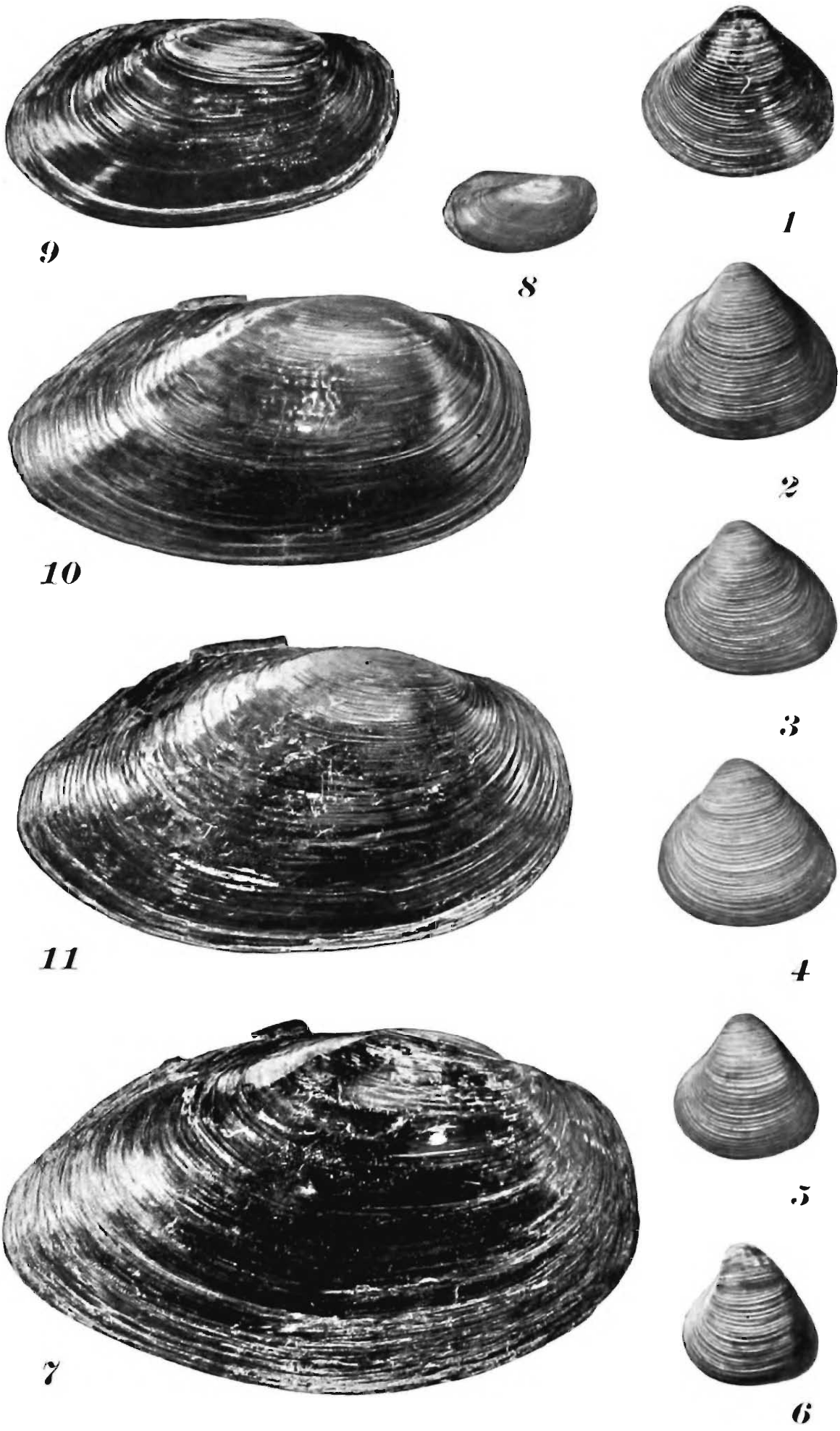
FIGS. 1–6.—A series of shells from the edge of the Helmand in the Afghan desert, illustrating variation in form and size.

Lamellidens marginalis, subsp. **rhadinaeus**, subsp. nov.

FIG. 7.—Type-specimen (phase A) from the desert near Nasratabad, Seistan.

FIGS. 8–11.—A series of shells of different ages from the Hamun-i-Helmand near Lab-i-Baring.

All the shells are shown of the natural size.



S. C. Mondul photo.

Mollusca of the Helmand.

Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1919.

NOTES ON FISH OF THE GENUS *DISCOGNATHUS* FROM INDIA AND PERSIA.

By N. ANNANDALE, *D.Sc.*, *F.A.S.B.*, *Director, Zoological Survey of India.*

(With Plates IX—XI.)

Although it is only a few months since I published notes on the Indian species of this genus,[1] a large amount of additional material is already available and I have been able to examine living specimens in districts so far apart as Seistan in Eastern Persia and the Nilgiri Hills in Southern India. The latter district is particularly important as it is the type locality for several of the forms described by Jerdon and Day. It is not yet possible to clear up all the difficulties concerning the Indian species and much more material is still necessary before the Assamese and Burmese forms can be adequately discussed, but I hope that these notes may lead to further investigation of the genus, which is a particularly interesting one from a biological point of view.

In my former notes I neglected to mention the species described by Tate Regan from the North Western Frontier of India under the name *Discognathus wanae*,[2] and I gave no reference to the Persian form described by Berg as *Garra persica*.[3] The latter is probably a local race of *D. lamta*, but the former seems to be a very distinct species.

Two species from South India have been brought to my notice too late to be discussed in this paper. They will be described shortly by Mr. C. R. Narayan Rao under the names *D. platycephalus* and *D. bicornutus*. These species must be attributed to Mr. Narayan Rao, but I have noted some of their more salient characters in the key to the species printed here. These characters he has demonstrated to me.

The genus as a whole falls into two sections, distinguished by the degree of differentiation of the adhesive disk behind the mouth on the ventral surface. Both these sections are found in Africa as well as in Asia and both extend into the Palaearctic part of the latter continent, but the most highly differentiated forms occur mainly in India and Malaysia, in which countries those with the simpler type of disk are practically absent. Among those in which the disk is best developed, a secondary differentiation occurs in

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[1] Annandale, *Rec. Ind. Mus.* XVI, pp. 113, 129 (1919).
[2] Tate Regan, *Ann. Mag. Nat. Hist.* (8) XIII, p. 263, fig. A (1914).
[3] Berg, *Ann. Mus. Zool. St. Petersbourg* XVIII, p. lxi (1913).

certain species in the naked chest and the specialization of the muscles of the thorax. In the following key I have made use of the first of these characters in my primary division and of the second in the first secondary division. It is possible that the two primary groups will have to be regarded ultimately as distinct genera.

Key to the Indian and Persian species of Discognathus.

I. Mental disk small, less than half as broad as head, without a specialized posterior border; margins of opercula meeting in the middle line well behind the disk.
  A. Disk very imperfectly differentiated, without free posterior border; barbels 4; chest covered with scales ... *D. adiscus.*
  B. Disk with posterior border free but lateral borders not so; barbels 4; chest covered with scales ... ... *D. wanae.*
  C. Disk with both lateral and posterior margins free; 2 barbels; the whole of the ventral surface naked ... *D. phryne.*

II. Disk large, more than half as broad as head, with a free lateral and posterior granular border, entirely or almost separating the opercular margins.
  A. Chest covered with scales, not much flattened; its muscles not highly differentiated.
    1. No barbels. *l.l.* 44 ... ... *D. imberbis.*
    2. 4 barbels. *l.l.* 36-41.
      a. Pupil of eye in middle or anterior half of head: eye usually visible from below; snout tuberculate in male but not forming a very distinct process.
        i. Opercular borders approaching one another at an obtuse angle on the ventral surface, widely separated by mental disk ... ... *D. lamta.*
        ii. Opercular borders approaching one another closely at an acute angle behind the mental disk; disk subcircular ... ... *D. gotyla.*
      b. Pupil of eye distinctly in posterior half of head; eye (except in *D. gravelyi*) invisible from below.
        i. Snout moderately rounded, more or less produced and tuberculate, at any rate in adult male, immediately in front of or outside nostrils.
          a. Snout forming a single free conical process in front of nostrils in all individuals; opercular borders approaching one another at an acute angle on the ventral surface; length of head nearly 5 times in total length ... ... *D. stenorhynchus.*
          β. Snout produced into a pair of conical processes, one outside each pair of nostrils ... ... *D. bicornutus.*
          γ. Snout produced in male only; its process single, usually shorter than in *α*; opercular margins nearly transverse and widely separated on ventral surface; length of head at least $5\frac{1}{2}$ times in total length ... *D. jerdoni.*
        ii. Snout bluntly pointed, never produced in front of or outside nostril; slightly retroverted at tip.
          α. Dorsal profile from tip of snout to behind dorsal fin forming an even rather high curve; depth of body 5 times in total length ... ... *D. gravelyi.*
          β. Dorsal profile nearly straight; that of head sinuous; depth of body (in adult) nearly 7 times in total length ... ... *D. elegans.*
          γ. Top of head obliquely flattened; profile of head and anterior part of body a slanting straight line ... *D. platycephalus.*
  B. Chest naked, flattened, with specialized muscles.

1. Pectoral fins hardly longer than head, not nearly reaching ventrals ... ... *D. nasutus.*
2. Pectorals distinctly longer than head, nearly reaching ventrals ... ... *D. macrochir.*

SECTION I.—*Group of* Discognathus variabilis.

1863. *Discognathus* (*s.s.*), Bleeker, *Atl. Ichth.* III, p. 24.

In this group the adhesive apparatus on the ventral surface of the head is comparatively little differentiated, the snout projects little beyond it, and the general facies of the fish is less peculiar, the ventral surface being less flattened and the caudal peduncle more distinct. As Boulenger has pointed out in discussing an African species (*D. quadrimaculatus* [1]) belonging to the group, it has a close resemblance to the eastern Asiatic genus *Crossochilus*, a genus which, according to most recent authors, is not found west or north of the Malay Peninsula; but there is a distinct difference in the structure of the mouth and in particular of the lower lip.[2] In this section of *Discognathus*, as also in the other species, the jaws are much less sharp than in *Crossochilus* and are never horny or bony, but always cartilaginous and covered with a thin epithelium. The upper lip is joined to the lower lip directly by a frenulum, but the lower lip itself is vestigial, disappearing entirely in most species in the middle of the jaw, though in some, as in *D. phryne*, it is represented by a delicate fold of integument that may be extended over the whole jaw. The transverse band of tissue which stretches in many species across the anterior margin of the mental disk just behind the lower jaw appears to be quite distinct, as is shown by the condition in *D. phryne*, from the lower lip. It is this band of tissue, however, which is labelled *l.l.* in my figure on p. 114, *Rec. Ind. Mus.*, Vol. XVI. The snout does not appear to be produced or tuberculate in any of these species.

It is possible that *Discognathus* is derived from *Crossochilus* and that the species of the first section are closely related genetically to that genus. The geographical difficulty is not so great as might appear at first sight, for the species *Cirrhina latia* is closely related to *Crossochilus*, in which indeed it is placed by Günther[3] and Vinciguerra,[4] and the range of *Cirrhina latia* extends from Upper Burma to Baluchistan.

The eponymous species of this group is found in Palestine and Mesopotamia. The three discussed here occur in the extreme east of Persia or on the North West Frontier of India, while *D. quadrimaculatus* is recorded from various lakes and rivers in the upper watershed of the Nile and *D. vinciguerrae* (which, so far as I can judge from Boulenger's figure,[5] also belongs to the group) from the White Nile and the Upper Nile.

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[1] Boulenger, *The Fishes of the Nile*, p. 180 (1907).

[2] For an excellent figure of the mouth of *Crossochilus*, see Weber and Beaufort, *Fishes of the Indo-Australian Archipelago* III, p. 232, fig. 96 (1916).

[3] Günther, *Cat. Fish. Brit. Mus.* VII, p. 71 (1868). [90].

[4] Vinciguerra, *Ann. Mus. Stor. Nat. Genova*, (2) IX (XXIX), p. 280 (1889-

[5] Boulenger, *Fish. Nile*, p. 185, pl. xxxi, fig. 4 (1907), and *Cat. Fresh-w. Fish. Africa* I, p. 347, fig. 261 (1909).

Discognathus adiscus, sp. nov.

(Pl. x, fig. 2; pl. xi, fig. 1.)

L. l. 36—38. D. 3/8. V 2/5.

This is a small species of slender habit. The dorsal profile from the tip of the snout to behind the dorsal fin is strongly and evenly arched; that of the caudal peduncle slightly concave. The ventral profile as far as the base of the caudal peduncle is convex. The head is of moderate size, its length contained about 5 to 5½ times in the actual total length. It is somewhat flattened above. The snout is rounded and smooth. It is shorter than the part of the head behind the eye. The nostril is situated nearer the tip of the snout than the eye. The eye is large and rather prominent; its length contained about 3½ times in the length of the head, and a little less than twice in the interorbital breadth; it is not visible from below. The pupil is situated near the middle of the head, and the upper margin of the eye near the dorsal profile. The mouth is large and almost straight. It is situated only a short distance behind the tip of the snout. The upper lip is well developed, covering the upper jaw, fringed at the margin and minutely granular. There are 4 short barbels. The lower lip properly so called is only developed at the sides and there is no transverse band of specialized structure behind the lower jaw, which is fully exposed. The mental disk is very imperfectly developed. It consists of a granular pad truncate or subtruncate in front, free at the sides, and more or less emarginate, but not free, posteriorly. The margins of the opercula meet at an acute angle on the mid-ventral line some distance behind it and the branchial openings extend well on to the ventral surface. The dorsal fin is nearly as high as the body. Its last undivided ray is cartilaginous and articulated. The pectorals, which do not nearly reach the ventrals, are rather narrow, pointed and distinctly shorter than the head. The caudal is long, distinctly lobed and with the lobes pointed. The scales are well developed but somewhat deciduous. They cover the whole of the body. There are 5½ scales between the lateral line and the dorsal, and 4 between the former and the ventral.

The pharyngeal bones and their teeth closely resemble those of *D. phryne* (*v. postea*), but the teeth are more slender.

The dorsal margin is pale bluish grey; there is a more or less distinct bluish mid-lateral streak, running from behind the head to the base of the caudal fin. The lower part of the head and sides and the ventral surface are yellowish-white.

Type-specimen, No. $\frac{2\,7\,6\,3}{1}$ F, *Z.S.I.* (*Ind. Mus.*).

Distribution.—This fish is extremely abundant in small watercourses and pools in the plains of Seistan. We obtained specimens from the following localities:—Nasratabad, irrigation channel in Consulate garden; pool in the desert 5 miles south of Nasratabad; pools in stream-bed 12 miles north of Nasratabad; channels in the reed-beds of the Hamun-i-Helmand near Lab-i-

Baring, and channel leading out of the Hamun 12 miles east of Lab-i-Baring; small watercourse, Lutak, southern Seistan.

Habits.—*D. adiscus* is gregarious and always lives in large shoals. In the day-time it stays at the bottom, feeding apparently on algae, but in the evening I have seen shoals swimming on the surface. All the individuals we found in the Hamun, which were not numerous, were dead or dying, and we found enormous numbers in a moribund condition, in which they floated on the surface, in pools of very foul water in a stream-bed north of Nasratabad. We did not find the fish in any but still or slow-running water.

I have placed this species in the genus *Discognathus* with some doubt, but I do not know where else to place it. The mouth differs distinctly from that of both *Cirrhina* and *Crossochilus*, though the structure of the gill-openings resembles that found in these genera. Moreover, the mental disk, though poorly developed and differing in shape from that of other species, is present, and the general facies is not unlike that of *D. quadrimaculatus*. On the whole I think that the species must be accepted as an extremely primitive representative of *Discognathus*. If this be so, its *provenance*, together with that of the other primitive species *D. variabilis*, *D. phryne* and D. *wanae*, would suggest that the genus perhaps originated in South Western Asia. It is noteworthy that it does not occur in Central Asia, and possibly the African species that are apparently allied, may be degenerate rather than primitive. Without examininig specimens I cannot express an opinion on this point.

Discognathus wanae, Regan.[1]

"Depth of body 4 in the length, length of head $4\frac{1}{2}$ to $4\frac{2}{3}$. Snout rounded, nearly as long as postorbital part of head; diameter of eye 5 in length of head; interorbital region flat, its width nearly $\frac{1}{2}$ length of head. Width of mouth $\frac{1}{3}$ length of head; two barbels on each side, shorter than diameter of eye. Upper lip with minute papillae near the margin; lower very narrow; behind it a circular disc divided into a papillose anterior and a smooth posterior portion, and with only the posterior edge free. Dorsal III 7; origin equidistant from tip of snout and base of caudal; first or second branched ray longest, nearly as long as head. Anal II 5. Pectoral extending $\frac{3}{5}$ of distance from its base to pelvics, which nearly or quite reach vent. Caudal deeply emarginate. Greyish, mottled with darker.

"Five specimens, the largest 80 mm. in total length." (Tate Regan). Mr. Regan has kindly informed me that there are about 36 scales in the lateral line and that both back and belly are covered with scales smaller than those on the sides.

I have not seen this species, the description of which I quote in full. It was described from Waziristan in the hills of the

[1] Tate Regan, *Ann. Mag. Nat. Hist.* (8) XIII, p. 263, fig. A (1914).

North West Frontier of India and comes from the same geographical district as the species (*D. phryne*) next to be described.

Discognathus phryne, sp. nov.

(Pl. x, fig. 3; pl. xi, fig. 2.)

D. 3/7. A. 2/5. L. l.36-39. L. t.5/5-6.

This species is apparently allied to *D. variablis*, Heckel, from which it differs in proportions and in its naked chest and back. Like *D. variabilis* it has only two barbels.

The size is small and the habit rather stout. The length of the head, the greatest depth of the body and the length of the caudal fin are approximately equal and are contained from $4\frac{3}{4}$ to $5\frac{1}{4}$ times in the complete total length. The dorsal profile is sinuous but nowhere strongly arched, rising in an almost even low curve from the tip of the snout to the anterior margin of the dorsal fin. The abdomen is convex. The snout is blunt and rounded and projects slightly beyond the mouth. Secondary sexual characters were not observed on the heads of specimens captured in winter. The nostrils are large and situated nearer the eye than the tip of the snout. The eye is small, its length being contained 3 to 5 times in the length of the head; it is lateral in position, its upper margin approaching the upper profile, and is situated near the middle of the length of the head. The upper lip is comparatively narrow and indistinctly fringed. The mouth is large and broadly arched. The lower lip is represented by a narrow, linear flap of tissue; posterior to this there is a transverse, minutely tuberculate band, obliquely truncate at either end and much narrower than the anterior flap; it is about as long as the upper lip. Posterior to this again lies the true mental disk, which is smooth and by no means highly developed. It is somewhat lozenge-shaped in the adult fish and considerably broader than long; its posterior and lateral margins are free. In shape and proportions it is somewhat variable. There is a small, blunt barbel at each angle of the mouth; its size is variable and it is sometimes reduced to a mere tubercle. There is no trace of anterior barbels. The dorsal fin starts considerably nearer the base of the caudal than the tip of the snout and slightly in front of the ventrals. Its undivided rays are soft and slender and the last, which is almost as long as the head, is articulated in its distal third. The pectorals are a little shorter than the head and do not nearly reach the ventrals when adpressed; they are set obliquely on the side of the body. The caudal peduncle is not clearly marked off. The caudal fin is large, distinctly cleft and with the two halves subequal or equal and bluntly pointed.

The scales are rather small. There is a relatively broad middorsal streak which is entirely bare and so also are the chest and abdomen. The muscles of the chest, however, are not highly specialized. The lateral scales are deciduous. In the young those

beneath the lateral line are poorly developed. The lateral line is conspicuous.

The pharyngeal bones are broad and very convex. They each bear twelve teeth, but the second tooth of the outer row is very short, though broad, and almost hidden by the others. The formula appears to be 6.3.3/3.3.6, but the teeth are very closely congregated and the rows difficult to distinguish. The teeth are fairly long and slender but shorter than those of *D. adiscus*, sharply pointed (except the second of the outer row) and slightly retroverted at the tip, which is obliquely truncate.

The colouration varies with the environment, but the scales, the upper part of the cheeks, the operculum and the dorsal surface of the head and body are always minutely speckled with black, and the specks are always more numerous on the back and on the top of the head than elsewhere. In individuals from very clear water they are so numerous as to give these regions a blackish colour. Larger black spots are sometimes present on the upper part of the sides, and a narrow blackish vertical bar can usually be distinguished on the distal end of the caudal peduncle. The ventral surface and the lower part of the head are white. The iris is speckled like the scales. The fins are colourless. In the young there is a bluish mid-lateral streak running along the body.

Type-specimen, No $\frac{97.8.7}{1}$ F., *Z.S.I.* (*Ind. Mus*) (from Seistan).

Distribution.—This species is very abundant in the hill country of Baluchistan at altitudes between 5,000 and 6,000 feet. A single specimen was taken by Mr. S. W. Kemp and myself, with many of *D. adiscus*, in an irrigation channel at Nasratabad, Seistan.

Habits.—*D. adiscus* is gregarious and lives as a rule among algae on the bottom of slow-running water-channels and pools. In the outflow of the Kushdil Khan reservoir in the Pishin district north of Quetta large numbers were observed opposite the places where water flowed in from underground sources. The weather was very cold at the time and this water was warmer than that which came from the reservoir. The fish were feeding on a green filamentous alga.

The species seems, as already stated, to be closely related to *D. variabilis*, Heckel, and is doubtless the one referred to by Zugmayer[1] as intermediate between that form and *D. lamta*. It is almost certainly identical with the *D. variabilis* mentioned in the editorial note prefixed to Tate Regan's account of fish from Seistan in *Journ. As. Soc. Bengal*, (n.s.) II, p. 8 (1906).

SECTION II.—*Group of* Discognathus lamta.

1838. *Platycara*, McClelland, *Journ. As. Soc. Bengal*, VII, (2), p. 944.

This group is certainly more highly developed than that of *D. variabilis*. The mental disk is always relatively large and is a

[1] Zugmayer, *Abh. Bayerisch. Ak. Wiss. Math.-phys. Klasse* XXVI (6), p. 24 (1913). These specimens were from the Pishin River in northern Baluchistan. There are two Pishins in Baluchistan, the one north of Quetta and one, referred

highly specialized structure consisting essentially of three parts—an anterior transverse band of soft tissue covered with minute tubercles, a central almost cartilaginous disk with a smooth surface, and a posterior and lateral free border of soft tuberculated integument. It is therefore a much more efficient organ of adhesion. In all the Indian forms with which I am acquainted the disk completely separates the antero-ventral margins of the opercula, but Gray and Hardwicke in their "*Illustrations of Indian Zoology*" figure these borders in *D. gotyla* as meeting behind the disk (Vol. I, pl. lxxxviii, fig. 3) and this also appears to be the case in certain African forms. In specimens I assign to *D. gotyla* the borders nearly meet. In the Indian forms the snout, either in the adult male or in both sexes, is tuberculate and often produced between or outside the nostrils.

In the Indian species the number of rays in the dorsal fin and of scales in the lateral line as a rule affords little or no assistance in specific diagnosis.

The fish of this group are mostly tropical, but a local race of *D. lamta* is found as far north as Palestine, while either *D. jerdoni kangrae* or a closely allied form inhabits mountain streams in the Aden hinterland. In Africa species are found in the Nile valley, in the great African lakes and in the eastern waters of Abyssinia. In Asia the range of the group extends from Palestine to Yunnan, Southern India and Borneo. It seems to have its headquarters in the hill country of Southern India and Assam, but the Assamese species or races have not been investigated since the time of McClelland. In streams at the base of the Nilgiris I found four distinct species.

Discognathus lamta, Day [1].

1919. *Discognathus lamta,* Annandale, *Rec. Ind. Mus.* XVI p. 114, text-fig. 1 and p. 131, pl. ii, figs. 1, 1*a*.

Dr. Chaudhuri has recently taken specimens of this species near Seringapatam in Mysore. They differ slightly from North Indian specimens, but I have not sufficient material to establish their racial identity.

Discognathus persicus (Berg.).

"*Garra persica,* Berg, sp. n.[2]

"*Discognathus lamta* (*non* Ham. Buch.) Nikolsky, *Ann. Mus. Zool. St Petersbourg*, IV, 1899, p. 411 (No. 11706,11707).

D II 7, A II 5, 11.35 $\frac{4}{3\frac{1}{2}}\frac{}{4}$37.

11707. River Bampur in Eastern Persia. N. Zarundy 1898, 15–27. VII (6).

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to by W. T. Blanford in his "*Zoology and Geology of Eastern Persia,*" in Persian Baluchistan some little distance inland from the Arabian Sea.

[1] Buchanan's *Cyprinus* (*Garra*) *lamta* was probably, from its habitat, identical with McClelland's *Platycara nasuta* (1838) rather than with the *D. lamta* of authors. It is, however, impossible to establish this with absolute certainty.

[2] Berg, *Ann. Mus. Zool. St. Pétersbourg* XVIII, p. lxi (1913).

11706. Kiabad in Zirkuh (Eastern Khorassan). N. Zarundy 1898, 3.V (1).

" Near *Garra lamta* (Ham. Buch.), from which differs in having 7 branched rays in dorsal (in *lamta* Ham. Buch. 8, as much in *crenulata* Heck., *rufa* Heck., *obtusa* Heck.). Lower lobe of caudal shorter than head. Total length 75 mm.

" Barbels 4, very short, uppers $\frac{1}{2}$ diameter of eye, lowers $\frac{2}{5}$. Pupil in the second half of the head. Ventrals below anterior $\frac{1}{3}$ of dorsal. Snout projecting strongly beyond mouth. Upper lip well developed, not fringed. Width of the mouth less than $\frac{1}{2}$ length of head, rather equals the interorbital width. Caudal peduncle $1\frac{1}{2}$ - $1\frac{2}{3}$ times as long as deep. Eye supero-lateral, not visible from below. Depth of body 5·0–4·6 in its length (without caudal), head 4·5–4·3. Diameter of eye 4·1–4·0 in the length of head, 1·8 in the interorbital width. Pectorals 5·0–4·8 in the length of body (without caudal). Belly covered with scales. 4–5 round black spots on the dorsal near its base. A dark vertical bar on the caudal peduncle near the base of the caudal. Snout of breeding males with numerous conical horny tubercles.

" Eastern Persia." (Berg).

Discognathus jerdoni (Day).

(Pl. ix, figs. 1, 2; pl. xi, fig. 3).

1849. *Gonorhynchus Gotyla*, Jerdon (*nec* Gray), *Madras Journ. Lit. Sci.* XV, p. 309.
1867. *Garra Jerdoni*, Day, *Proc. Zool. Soc. London*, p. 288.
1878. *Discognathus Jerdoni*, Day, *Fish. Ind.* II, p. 528, pl. cxxii, fig. 6.
1889. *Discognathus jerdoni*, Day, *Faun. Brit. Ind. Fish.* I, p. 247.

This species is remarkable for its stout facies and very short, broad head, which differs considerably so far as the shape of the snout is concerned in the two sexes. The dorsal profile behind the snout is very nearly straight in the male and only slightly arched in the region of the dorsal fin in the female.[1] The snout is rounded and much longer, especially in the male, than the part of the head behind the eye. The nostril is very much nearer the eye than the tip of the snout. The eye is relatively large, especially in the male, in which its length is contained in the length of the head about 5 times and in the interorbital breadth twice. In the female the length of the eye is contained at least $5\frac{1}{2}$ times in the length of the head and from $2\frac{1}{4}$–3 times in the interorbital breadth. The branchial openings extend on to the ventral surface, but on the sides do not reach much more than half way up the head In the female the snout is smooth and very slightly concave in lateral profile. In the male it is traversed by two semicircular grooves. The first of these, which is deep and undercut though narrow, lies a short distance in front of the nostril, while the second is about equidistant from the first and from the tip of the snout. The short projection

[1] Day's figure (*Fish. Ind.*, pl. cxxii, fig. 6) is taken from a badly preserved specimen.

caused by the first groove bears several spiny tubercles and there is a short row of smaller horny tubercles on each margin of the second groove. The upper lip is broad, concealing the upper jaw, granular and minutely fringed. There is a narrow semicircular transverse granular band in front of the disk, which is transverse and more strongly arched anteriorly than posteriorly. Behind the disk there is a broader semicircular free border. There are four short tentacles. The opercular margins are almost transverse on the ventral surface. The chest is flattened but scaly and without specialized muscles. The dorsal fin is not so high as the body. Its last undivided ray is moderately stout and it has nine or ten rays in all. The pectorals are broad and expanded and have the outer ray flattened. They are shorter than the head and their base is oblique. The scales are large. There are 3 or $3\frac{1}{2}$ above the lateral line and the same number between it and the ventral. The colour varies with the environment. Specimens from the Bhavani River at the base of the Nilgiris are very dark olivaceous on the sides and back and white on the ventral surface. All the fins are greyish but the pectoral fins have white borders. The rays of the caudal are white but the middle third of the membrane is blackish. In a specimen from a small muddy stream running into the Bhavani the colours are much paler, but there is no dark mid-lateral streak and no spot behind the operculum.

The largest specimen I have seen, an adult male from near Mettapolaiyam, is 184 mm. long.

The species is common in the Bhavani River near the base of the Nilgiris both before and after the stream leaves its gorge. It lives in places where the stream-bed is rocky and the current strong. Jerdon found it in the Manantoddi as well as the Bhavani and Day records it also from the Wynaad. I have seen a small and probably immature specimen which seems to belong to the species from the Nasik district of the Bombay Presidency.

Subsp. **kangrae**, Prashad.

1878. *Discognathus lamta*, Day, *Fish India* II, p. 528 (in part), pl. cxxiii, figs. 1, 1*a*.

1919. *Discognathus kangrae*, Prashad, *Rec. Ind. Mus.* XVI, p. 163, figs. 1, 1*a*.

This form seems to be no more than a local race of *D. jerdoni*, distinguished by its longer head and smaller eye.

Capt. Donald, Warden of Fisheries in the Punjab, has recently presented to the Indian Museum through Dr. Baini Prashad a series of specimens from hill-streams in the Kangra valley. They establish the fact that the fully developed adult male is identical with the form figured by Day in the plate cited.

Discognathus stenorhynchus (Jerdon).

(Pl. ix, fig. 3; pl. xi. fig. 4).

1848. *Gonorhynchus stenorhynchus*, Jerdon, *Madras Journ. Lit. Sci.* XVI, p. 310.

This species is closely related to *D. jerdoni*, but can be distinguished at once by the structure of the snout and by its relatively longer head. The snout, *in both sexes and at all ages*, is greatly produced in front of the nostrils, forming a regular conical forwardly-directed process, which however does not extend as far forward as the actual tip. As in *D. jerdoni*, this process is formed by a semicircular groove which passes below it. It bears at its free extremity two rows of spiny tubercles. There is a second groove some distance in front of the first which transforms the actual tip of the snout into a second process, which is directed forwards and slightly upwards and bears a number of small spiny tubercles on its posterior surface. The dorsal fin is rather less high than in *D. jerdoni* and the two larger unbranched rays are thicker and stouter. A third (anterior) unbranched ray may be present or absent. The pectoral fins are relatively short and narrow, rounded at the tip and oblique. The chest is not so flat as in *D. jerdoni*. The scales are rather smaller, though of the same number in the lateral line. There are $3\frac{1}{2}$ between the lateral line and the dorsal fin and $2\frac{1}{2}$ or 3 between the former and the ventral.

The colour of fresh specimens is as follows:—the sides and back pale yellowish above changing to pink below. All the fin-rays are somewhat infuscated and there is a row of dark spots along the base of the dorsal fin. An obscure dark mid-lateral line extends from behind the head on to the caudal fin. The iris is golden yellow. The colours have faded considerably in specimens in spirit.

I have examined thirteen specimens, the largest of which is 90 mm. long. The snout is produced in individuals less than two inches long.

Distribution.—This fish is only known from the base of the Nilgiri Hills. My specimens were taken in a small muddy stream (the Nierolay) which runs into the gorge of the Bhavani River some 12 miles above Mattapolaiyam in August.

Discognathus gotyla (Gray and Hardwicke).

(Pl. x, fig. 1; pl. xi, fig. 6).

1832. *Cyprinus gotyla*, Gray & Hardwicke, *Ill. Ind. Zool.* I, pl. lxxxviii, figs. 3, 3*a*.

1867. *Garra gotyla*, Day, *Proc. Zool. Soc. London*, p. 288.

This little species is also closely related to *D. jerdoni*, but the eyes are in the middle of the head, the head is large and the structure of the snout is different. The three specimens I have examined are perhaps not fully adult, but the secondary sexual characters are fairly well developed. The length of the head is contained in the total length a little more than five times. The eye is very large, its length being contained a little more than four times in the length of the head. The dorsal profile of the head is convex in the female. In the male there is a short process between the nostrils, bearing several relatively large spiny tubercles. The

anterior semicircular groove on the snout is not strongly developed. The mental disk is subcircular and of very large size. It is completely surrounded by a granular border. The opercular and preopercular margins are adherent on the ventral surface. The former approach one another at an acute angle and almost meet behind the disk. The dorsal fin is higher than the depth of the body. The pectorals are large and pointed and have the outer ray somewhat expanded. They are nearly as long as the head.

The colour is dark olivaceous with traces of several paler longitudinal streaks on the caudal peduncle. There is a dark spot behind the operculum and a dark median streak on the caudal fin. The ventral surface is pale.

Day states that the species grows as long as $5\frac{2}{5}$ inches. My specimens are about 50 mm. long.

Distribution.—Day states that the species is abundant at the base of the hills in the Bhavani River but rarer in the Sigur. I took two males and a female in the Nierolay stream at the base of the Nilgiris in August, with a number of specimens of *D. stenorhynchus* and one of *D. jerdoni*.

Discognathus elegans, sp. nov.

(Pl. ix, fig. 4; pl. xi, fig. 5).

This species is distinguished by its elongate form and by the structure of the snout, which bears numerous patches of horny tubercles but is not produced between or outside the nostrils.

The dorsal and ventral profiles of the body and the tail are nearly parallel and the depth of the body is contained more than six times in the total length. The head is short and rather narrrow, its length being contained nearly six times in the total length. The snout is more than twice as long as the part of the head behind the eye. Its dorsal profile is concave, the posterior transverse groove found in certain other species between the nostrils being represented by a broad depression. There is a narrow anterior transverse groove, which extends backwards on the sides of the head nearly as far as the anterior margin of the eye. There are about seven groups of horny tubercles on the snout, but some of them may coalesce or be subdivided. The nostril is very much nearer the eye than the tip of the snout. The eye is of moderate size, invisible from below. The snout is rounded in ventral view. The upper lip, which is fringed and granular, is relatively small, exposing both jaws. There are four very small barbels, those at the angle of the mouth being almost vestigial. The mental disk is transverse and lens-shaped. There is a narrow band of granular tissue in front of it and it is surrounded on three sides by a broad granular free border, which is slightly emarginate near the angle of the jaw on each side. The opercular borders are practically transverse on the ventral surface and are widely separated. The chest, and indeed the whole ventral surface, is flat but scaly and without specialized muscles. The dorsal fin is higher than the depth of the body; its

undivided rays are weak. The pectorals are as long or very nearly as long as the head, pointed and not much expanded. The ventrals, the anal and the two lobes of the caudal are also elongate and pointed. The scales are rather small. There are $4\frac{1}{2}$ between the lateral line and the dorsal and $3\frac{1}{2}$ between the former and the ventral. The number in the lateral line is the same as in other Indian species of the group.

The colour is dark olivaceous without definite markings. The ventral surface is yellowish-white The fins are infuscated, but the paired ones have a pale border.

This is the largest species of the genus with which I am acquainted. The type-specimen is 216 mm. long and the local fishermen state that individuals one cubit long are sometimes captured.

Type-specimen, No. $\frac{9798}{1}$ F, *Z.S.I.* (*Ind. Mus.*).

Distribution.—I have seen this species only from the gorge of the Bhavani River at the base of the Nilgiris, where it was taken with *D. jerdoni* in August. I have examined six specimens.

D. elegans is related to *D. gravelyi* from Burma, but the form is more elongate, the snout is tuberculate and there are considerable differences in the structure of the mental disk. From *D. platycephalus*, Rao it is distinguished by its more elongate form and more convex head. *D. ceylonensis* (Bleeker)[1] seems to be an allied species.

ADDENDUM.

The True Cyprinus lamta *of Buchanan.*

Dr. B. L. Chaudhuri has kindly drawn my attention to a quotation from Buchanan's manuscript notes which casts some light, in conjunction with the same author's original figure of "Cyprinus godiyari," on the identity of his *Cyprinus lamta*.

This quotation will be found on page 81 of Day's volume on the fisheries and botany of Bengal in Hunter's *Statistical Account of Bengal* (1876). He says, quoting Buchanan, "the *Godiyári* is another small Cyprinus found in the same places," *i.e.* in small streams among rocks in the Bhagalpur district; while in a footnote to the name *Godiyári* he adds, apparently on his own authority, "*Cyprinus lamta*, Ham. Buch. Fish. Ganges, p. 343, and MS. drawings No. 105, as *Cyprinus godiyari*."

Buchanan's MS. drawing No. 105 is still in the possession of the Asiatic Society of Bengal. It comprises three figures, one a finished coloured drawing[2] of the whole fish, the others outlines of the dorsal view and of the ventral surface of the head. These figures represent a species unknown to me but apparently allied to

[1] *Garra* (*Garra*) *ceylonensis*, Bleeker, *Versl. en Meded. Afd. Natuurk.* XV p. 239 (1863).

[2] McClelland gives a rather poor reproduction (sufficiently accurate in essentials) of this drawing in *Asiatic Researches* XIX, pl. xliii, fig. 2 (1839).

D. nasutus. Possibly it is *D. macrochir* (McClelland), but the figure of the head is unfinished and shows very little detail. The figure is labelled "Cyprinus godyari" in Buchanan's handwriting. The species figured is *not* the *D. lamta* of Day's *Fishes of India* and of subsequent authors. If we are to accept Day's identification on this occasion, the *D. lamta* of his later works will have to receive some other name; but the only point in favour of this is the fact that Buchanan himself was of the opinion that the Lamtá of the Gorakhpur district was identical with the Godiyári of the Bhagalpur district (*op. cit.*, p. 103). Considering the universal confusion of species that has followed, it is by no means improbable that Buchanan himself did not distinguish them clearly and that his *Cyprinus lamta* was, as I have suggested elsewhere, a composite group rather than a single species. It must be remembered that Day, who had himself collected different forms of *Discognathus* in the Bhavani River (where at least four quite distinct species occur), failed in the end to recognize their diversity. The only way in which the point can be settled is by a thorough ichthyological survey of the small streams of the Bhagalpur and Gorakhpur districts.

July 21st, 1919.

EXPLANATION OF PLATE IX.

Species of *Discognathus* from South India.

Discognathus jerdoni (Day).

FIG. 1.—Adult male from the Bhavani River near Mattapolaiyam, Coimbatore District. Actual length 184 mm.

„ 2.—Adult female from the same locality. Slightly smaller than male.

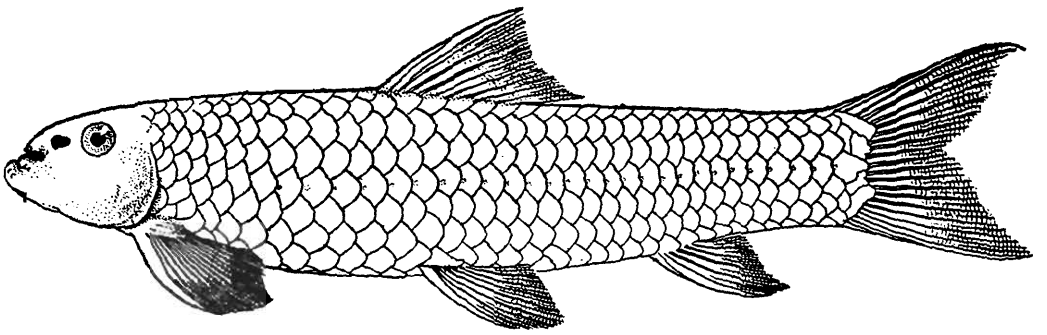
Discognathus stenorhynchus (Jerdon).

FIG. 3.—Adult male from small stream running into the Bhavani gorge at the base of the Nilgiris. Actual length 90 mm.

Discognathus elegans, sp. nov.

FIG. 4.—Type-specimen (adult male) from the Bhavani gorge Actual length 216 mm.

Plate IX.



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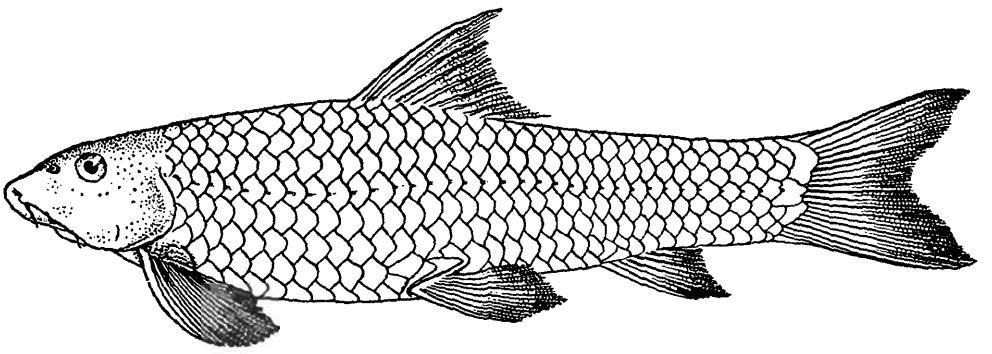

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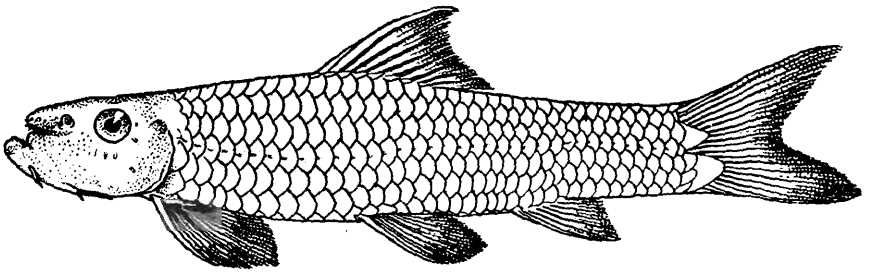

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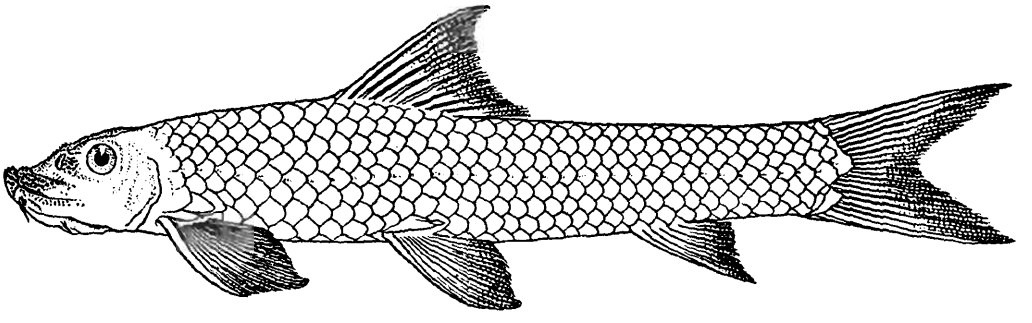


4.

A. Chowdhary del.

DISCOGNATHUS FROM SOUTH INDIA.

EXPLANATION OF PLATE X.

Species of *Discognathus* from South India and Eastern Persia.

Discognathus gotyla (Gray and Hardwicke).

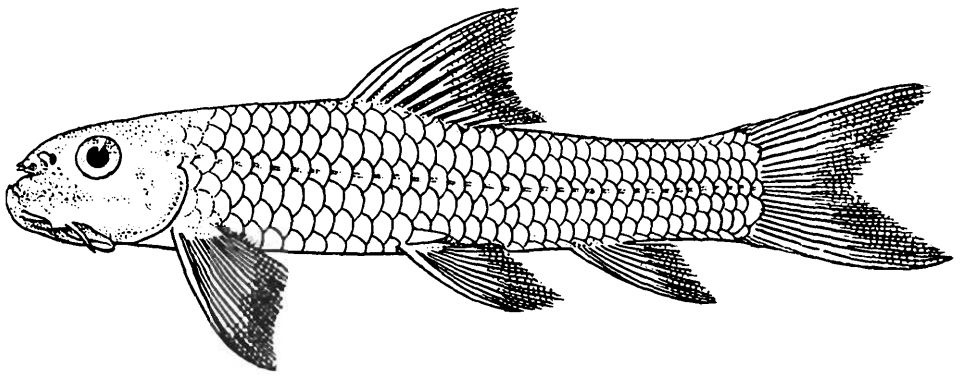
FIG. 1.—Young male from small stream running into the Bhavani gorge at the base of the Nilgiris. Actual length 50 mm.

Discognathus adiscus, sp. nov.

FIG. 2.—One of the type-specimens from Seistan (× 1½).

Discognathus phryne, sp. nov.

FIG. 3.—Type-specimen from Seistan (× 1½).



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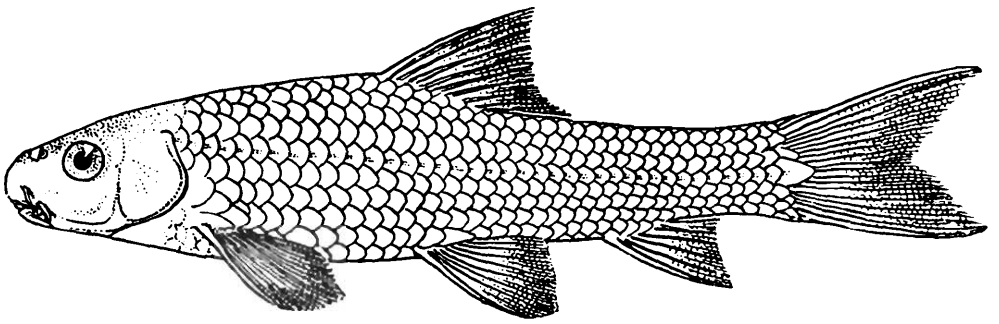

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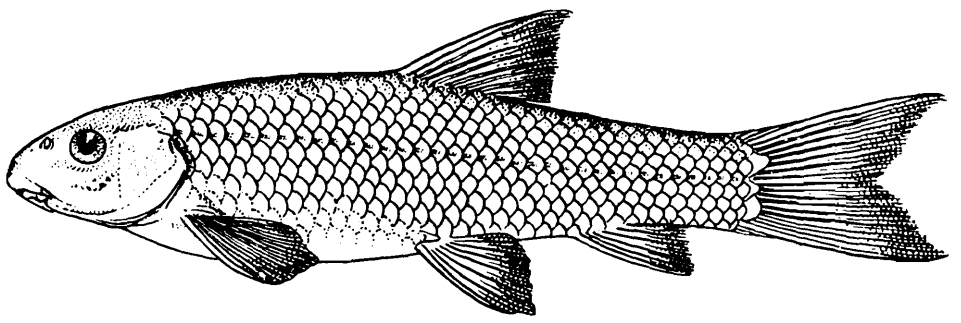


3.

A. Chowdhary del.

DISCOGNATHUS FROM INDIA & PERSIA.

EXPLANATION OF PLATE XI.

Mental disk and pectoral fins of Indian and Persian species of *Discognathus*.

FIG. 1.—*D. adiscus*, sp. nov.

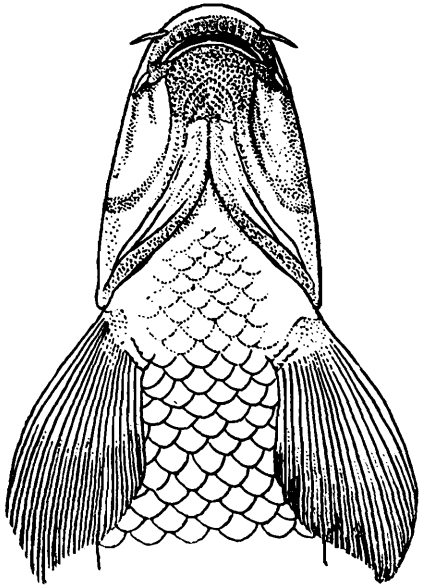
,, 2.—*D. phryne*, sp. nov.

,, 3.—*D. jerdoni* (Day). Adult male.

,, 4.—*D. stenorhynchus* (Jerdon). Adult male.

,, 5.—*D. elegans*, sp. nov. Adult male.

,, 6.—*D. gotyla* (Gray & Hardwicke). Young male.



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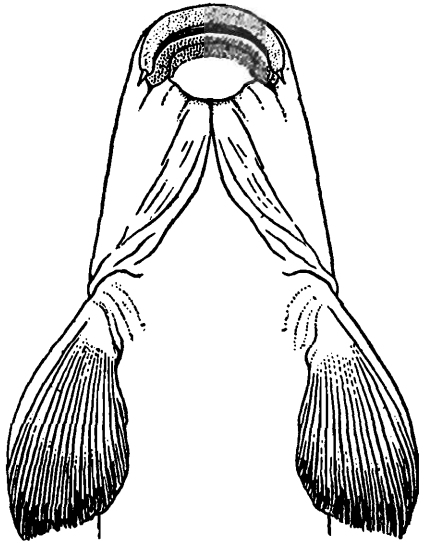

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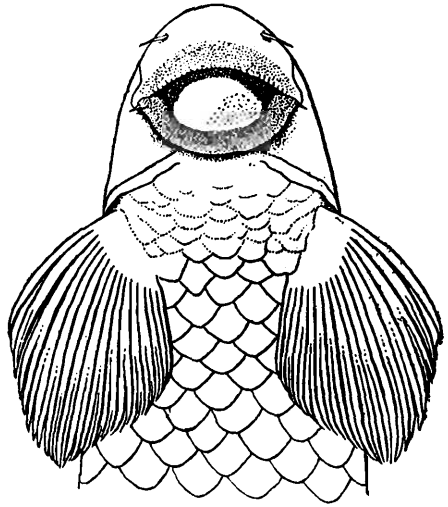

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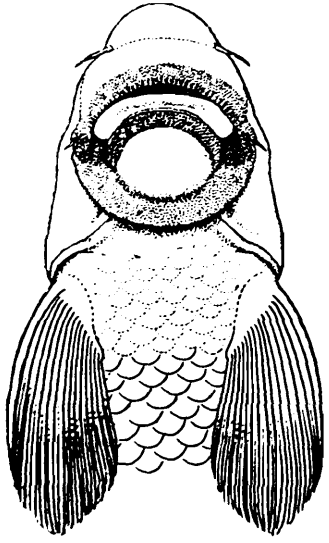

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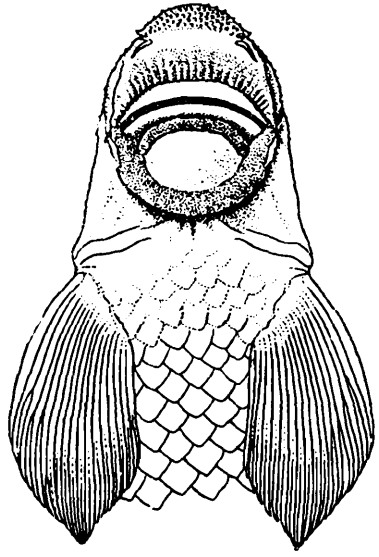

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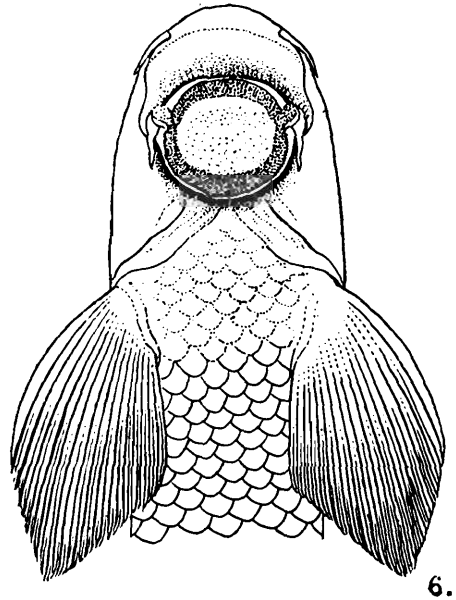


6.

A. Chowdhary del.

DISCOGNATHUS FROM SOUTH INDIA & PERSIA

Plate XI

NOTES ON ODONATA COLLECTED IN SEISTAN AND BALUCHISTAN IN WINTER

By MAJOR F. C. FRASER, *I.M.S.*

LIBELLULINAE.

Genus **Orthetrum.**

O. taeniolatum, Kirby.

Two males taken at Saindak near the Persian frontier, W Baluchistan, 17-11-18. $\frac{8749}{HI}$. [Dragon-flies I believe to have belonged to this species were also seen near the Hamun-i-Helmand in December. *N. A.*].

One specimen is normal, the other departs from the type by having only one row of cells between *Rs* and *Rspl* in all wings. Both specimens are fully adult and pruinosed.

In the collection are two specimens of Libelluline larvae, taken in the Residency garden, Quetta, 10-11-18. These belong to the genus *Orthetrum* and are probably *taeniolatum*. They closely resemble larvae of the latter taken in the Deccan, where they are common in shallow streams, concealed beneath curtains of *Spirogyra* and other water-weeds. The eyes are prominent and strongly angulated outwards; the body is depressed and squat and the dorsal carina of each segment, except the 10th, ends with a sharp, robust spine. The whole body is hairy, this coat serving to pick up debris and flocculent detritus during life, which serves both for concealment from its foes and as an ambush for its prey.

[The larvae were taken among dense weeds in a pond fed by an underground source of water distinctly warmer than the air at the time. *N. A.*].

AESCHNINAE.

Genus **Hemianax.**

Three *Aeschnid* larvae from Hanna Stream, *ca.* 6,000 ft., near Quetta, Baluchistan, 10-11-18. $\frac{8748}{HI}$. None are fully grown so that it is impossible to tell to what the insects belong by a study of the tracheation, but I think that there is no doubt that these are the larvae of *Hemianax ephippiger*, Selys, a common insect around Quetta. [These larvae are from a small stream with a luxuriant growth of Characeae, amongst which they were concealed. *N. A.*]

AGRIONINAE.

Genus **Ischnura.**

I. elegans, Van der Lind.

$\frac{8746}{HI}$, $\frac{8747}{HI}$, $\frac{8749}{HI}$. Three females, all differing in their colour scheme; this due partly to a teneral condition and partly due to the polychroism customary in this species. I have compared these with a series from Mesopotamia where the insect is very common and find that teneral forms are usually of a bright orange colour, especially as to the thorax. The orange pigment is soon absorbed and replaced by a greenish-yellow. Progressively with the absorbtion of the yellow pigment, blue is laid down, so that a series of forms is met with, passing from orange and yellow, through green to blue. Pari-passu with this, black pigment is deposited until it largely obscures the ground colour. Thus the eye-spots are often absent in the very early stage, being replaced by a broad orange fascia which soon changes through yellow and green, to blue, the change beginning from the front and extending backwards. At the same time, the black fascia which crosses the vertex, extends backwards and gradually laps round the area which is eventually to form the eye-spot. Evidence of this may actually be seen in the specimens quoted. The humeral fascia, usually found in this species, is unenclosed in all three specimens, but two small, black spots on the sides indicate the genesis of a posthumeral stripe.

In one specimen, the second abdominal segment bears a somewhat quadrate, black spot on the dorsum which is absent in the other two. This specimen is a bright orange colour and has the eye-spots fully developed. There is no doubt that some specimens retain the original orange colouring throughout imaginal life. The other two specimens are orange and blue respectively but have no eye-spots nor the quadrate spot on the second abdominal segment. All other markings are the same as the first specimen. In my Mesopotamian specimens, a regular series graduating from the one to the other may be seen so that there is no doubt that the insects are identical.

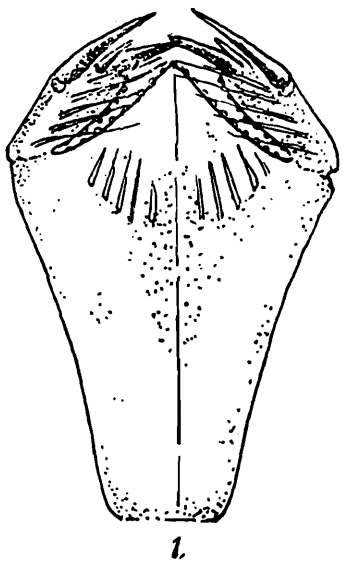


FIG. 1.—Mask of larva of *Ischnura elegans*?

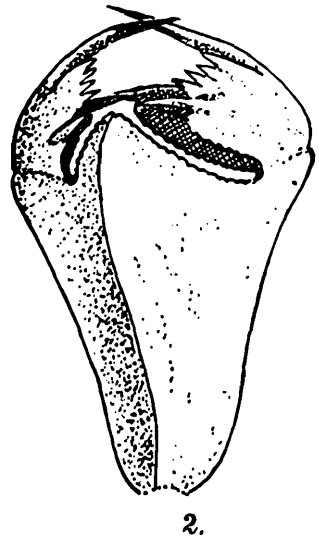
It is possible to divide up a number of Agrionine larvae in this small collection into two species. (The age of the larvae varies somewhat widely). One of these forms closely resembles the larvae of *Ischnura senegalensis* but it is probably the larvae of *I. elegans*. The mask (fig. 1) is long

and flat; the anterior border projects well forward between the palps and is furnished along its free border with minute teeth. The opposed borders of the palps are similarly armed and each is furnished with a strong movable hook and five long, stout setae, directed inward. In addition, each has a robust spine at its end and a smaller one between this and the movable hook. The caudal lamellae are more or less lanceolate and acuminated at the distal end. The tracheal ramification is pigmented and the lateral borders of the lamellae spined, the spines being robust on a little less than the basal half, and rather minute for rather more than the distal half. At the junction of these two different kinds of spines can be seen, in some specimens at least, a very faint suggestion of a transverse line, the only sign of the nodate character of the lamellae. The ends of the tibiae are richly tufted with spinous hairs and spines.

These larvae were taken along with the two Libelluline larvae mentioned above, in the Residency garden, Quetta. One imago was taken at Lab-i-Baring, Seistan, "lying on the surface of the water in channel in reed-beds in the Hamun," 10-12-18, and the other two at Kirtaka, W Baluchistan, near Afghanistan frontier, "among coarse grass growing on sand round a small spring." The females of *Ischnura* commonly lie up among coarse herbage, in the neighbourhood of water, whilst the males rarely stray far from the neighbourhood of water.

INDETERMINATE LARVAE.

The other larvae (from the rice-beds of the Hamun-i-Helmand near Lab-i-Baring) combine some of the features of an Agrionine larva with those of a Lestine. The middle-lobe (fig. 2) is typically Agrionine; there is no suggestion of a middle notch as seen in the other family but the palps are highly differentiated and the movable hook is of great length.



2.

FIG. 2.—Mask of indeterminate larva from the Hamun-i-Helmand.

There is a stout hook on both sides of the movable one and the space between the outer hook and this is deeply serrated. The border of the inner hook is lamellated, its edge being furnished with a row of closely-set, teeth-like processes, similar to rows on the border of the middle lobe and outer border of the palp. The palps appear to be more or less cupped by the lamellated extension.

The anal appendages are also of unusual character and obscurely nodate. They are lanceolate in shape and doubled on themselves like a half-opened leaf. The outer border and midrib are spined for about two-thirds of the proximal end and the distal portion is deeply pigmented in its outer half, in fact almost black in some specimens. The specimens are young so that nothing is learnt from the tracheation.

The larvae of dragonflies usually hibernate during the winter, and it is surprising to find that so many were taken in an active condition during two of the coldest months of the year. [The temperature was as a rule well below freezing-point at night at the time they were captured. The water of the streams and pools at Quetta in which the larvae were found was, however, distinctly warmer than the air, while the channels and pools in the Hamun-i-Helmand were protected from wind and frost by the reeds. *N A.*].