OBSERVATIONS ON THE ECOLOGY OF CERTAIN FISHES AND CRUSTACEANS ALONG THE BANK OF THE MATLA RIVER AT PORT CANNING.

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INTRODUCTION.

Through the courtesy of the Indian Museum the writer was able to work at Port Canning from June 27 to July 9, and at the Museum until July 18, 1930. It was thus possible to make observations on the animals which live in and along the shores of the Matla River in the Ganges Delta. The tide at this point had a vertical range of 10 to 12 feet. The salinity of the water at the surface in the middle of the river at low tide at 12 M. on July 6 was 27·79. At the same place, during a rain on July 8 at 7 A.M. at high tide the salinity was 26·40. At various times temperatures and humidities of the air were observed. These are given in Table I. Water temperatures were also taken (Table II) in small pools, where beach gobies lived on July 7 On that date it was cloudy until 12 M.; then rain came and continued all night. More such observations would have been made, but I made the mistake of waiting for a clear, sunny day in order to compare pool temperatures during clear and rainy weather—and there are no clear days during the rainy season at Port Canning. The soil everywhere in this locality is a fine, heavy clay brought down by the river. A cross-section of the bank of the river is shown in Figure 1.

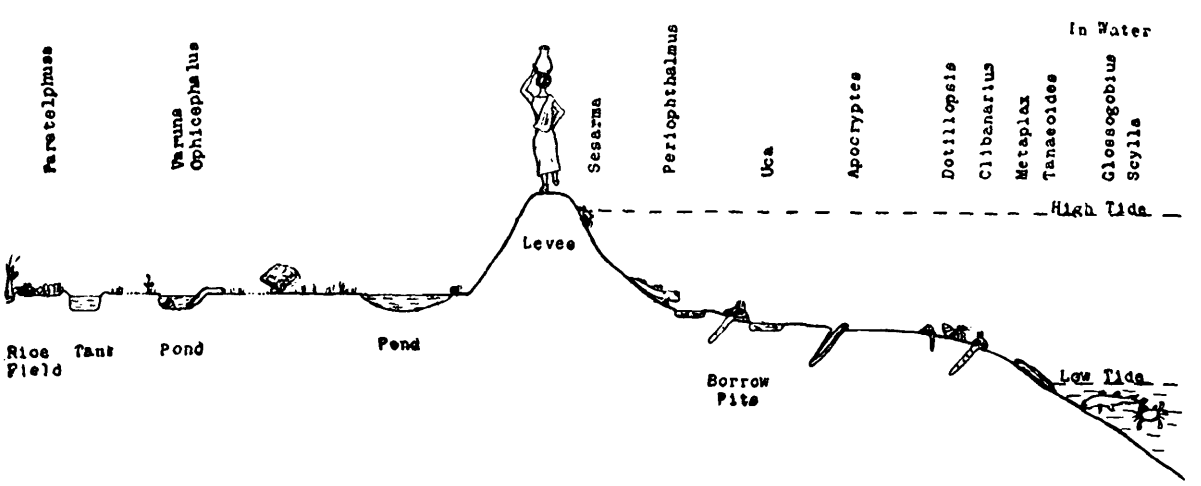

FIG. 1.—Section through the west shore of the Matla River at Port Canning. All animals of course are represented on a much larger scale than their habitats.

The writer makes grateful acknowledgment to the staff of the Indian Museum for assistance in scientific matters and for many other courtesies; especially to the Director, Col. R. B. Seymour-Sewell, and to Dr. S. L. Hora. Two collectors, R. Hodgart and Ganoor gave excellent service at Port Canning. Dr. Hora identified all the fishes, except one goby which was sent to Bruno Eggert, Tübingen, Germany.

Dr. C. B. Wilson identified the copepods ; H. J. Van Cleave, the anthocephalans ; H. W. Manter, trematodes ; G. R. LaRue, cestodes ; M. J. Rathbun, crabs ; Waldo Schmitt, hermit crabs.

OBSERVATIONS ON FISHES AND CRABS.

In the following list constituents of foods are given as estimated percentages by volume. The first number after a parasite indicates the percentage of hosts infested ; the second, the average number of parasites per host.

PISCES.

Aoria gulio (Hamilton-Buchanan).

Four individuals of this brackish-water species were examined on July 4 ; length : 87-132 mm. ; ave. : 108 mm. A snail was found in the stomach of one fish ; the others contained no food, Parasites were abundant : on the gills was a copepod, *Ergasilus nanus* Beneden (100 : 23·3) ; larval trematodes were encysted on the gills (50 :12·5) ; minute nematodes lurked among the gill filaments (25 : 2·0) ; peritoneal nematode cysts were present (25 : 5·0) ; and an acanthocephalan, *Acanthosentis antispinus* Verma & Datta (50 : 5·0) occurred in the intestine.

Saccobranchus fossilis (Bloch).

Ten specimens of this air-breathing fish were examined on July 14 ; length : 213-161 mm. ; ave. : 193 mm. As they had been kept overnight by a collector, they contained little or no food. All females were nearly ready to spawn. Parasites : *Trypanosoma saccobranchi* sp. nov. (40 :) ; visceral *Diplostomum* cysts (100 : 139·3) ; *Agamofilaria* sp. cysts in mesentery (100 : 4·1) ; *Gnathostoma* juv. cyst in mesentery (10 : 0·1).

Ophicephalus striatus Bloch.

Two females were examined on July 7 ; length : 246, 254 mm. One had eaten a water bug and contained a hepatic tapeworm cyst (*Tetracampos* sp. ; 50 : 0·5).

Ophicephalus gachua Hamilton-Buchanan.

A male, 120 mm. long ; examined on July 7 contained no food but was infested with 9 gill copepods, *Ergasilus gibbus* Nordmann (100 : 9), and three mesenteric nematode cysts (100 : 3).

Glossogobius giurus (Hamilton-Buchanan).

Four males and one female were examined on July 6 ; length : 108-203 mm. ; ave. : 143 mm. Two had eaten fishes. Parasites : *Agamofilaria* sp. cysts (100 : 7·5).

Apocryptes lanceolatus (Bloch & Schneider).

Twenty specimens were examined, ten on July 2 and ten on July 4. Length of first lot : 36-89 mm. ; ave. : 63·1 mm. ; second lot : 100-145 mm. ; ave. : 125 mm. The food was as follows : insect larvae, 0·5 ; filamentous algae, 46·9 ; plant remains, 65·5 ; mud, 36·1. Parasites : gill copepods, *Ergasilus nanus* Beneden (30 : 0·5).

Taenioides rubicundus (Hamilton-Buchanan).

Ten specimens were examined on July 7 ; length : 89-160 mm. ; ave. : 119·8 mm. ; 8 males, 2 females. Food : copepods, *Pseudodiaptomus annandalei* Seymour-Sewell and *P. tollingeri*, s.-s., 13·5 ; amphipods, 43·5 ; isopods, *Parapsudes* sp., 17·5 ; mysid shrimps, 12·0 ; orbatid mites, *Mesoplophora* sp., many alive, 2·5 ; plant stem, 1 ; mud, 10. No parasites.

Periophthalmus cantonensis pearsei Eggert.

Ten specimens of this little beach skipping goby were examined on July 2 ; length : 40-56 mm. ; ave. : 48·1 mm. The food was as follows : spider, 13·0 ; insects, 4·2 ; insect larvae, 2·0 ; shrimp, 25·5 ; crab, 8·5 ; isopods, 10·0 ; amphipods, 1·0 ; ostracods, 5·0 ; snails, 9·5 ; mud, 21·3. Parasites : larval cestode from duodenum (10 : 0·1) ; spiruroid from stomach, (10 : 0·1).

This fish lives high up on the bank but does not leave the river to go inland. It lives on the flats with fiddler crabs and wanders up and down with the tides ; especially where the mud is soft. It also goes in and out of the shallow puddles and swims about in the borrow pits and the little streams which trickle down the banks at low tide. On July 5 males with their dorsal fins erect were chasing females about on the flats.

CRUSTACEA.

Clibanarius padavensis de Man.

Ten specimens of this hermit crab were examined on July 5 ; length : 17-23 mm. ; ave. : 17·9 mm. The food consisted of algae, 12·3 ; vascular plants, 9·1 ; and mud, 78·6. No parasites.

Scylla serrata (Forsk.) de Haan.

Ten specimens (diameter of carapace : 78-133 mm. ; ave.: 101 mm.) of this portunid crab which were examined on July 3 contained the following food : crustaceans, 0·4 ; plant remains, 95 ; mud, 4·6. Barnacles (*Dichelaspis maindroni* Gruvel) were always found in the branchial chamber (100 : 34·4) ; and one crab carried an anemone on its back (10 : 0·1).

Dotillopsis brevitarsus (de Man).

Ten specimens of this little burrowing crab (diam. : 8·5-10 mm. ; ave. : 9·2 mm.) were studied on July 2. They had eaten nothing but mud. Visceral trematode cysts (*Levinsenella* sp.) were found (20 : 5·0).

Metaplax dentipes (Heller).

Ten crabs (diam. : 11·5-18·5 mm. ; ave. : 15·2 mm.) examined on July 1 had eaten vegetation (83·3), mud (10·7), and unknown substances (6·0). They contained parasites : a male isopod, *Leidya sesarmae* Pearse, attached to a gill (10 : 0·1) ; gregarines, *Steinina metaplaxi*, sp. nov. (10 : 13) ; and also in the intestine some minute ciliates (10 :) which were probably accidental or coprophagic.

Uca mani Rathbun.

Twenty fiddler crabs were examined on July 1 and 5 ; diameter : 16-25 mm. ; ave. : 20·1 mm. ; 7-22 mm. ; ave. : 14·5 mm. Food : plant remains, 0·5 ; mud, 99·5. Nematodes, *Rhabdochona uca*, sp. nov. (10 : 0·15) were found in the intestine ; cilliates (*Epistylis* sp. ; 75 : 17·3) were common in the branchial cavity.

Sesarma taeniolatum White.

This crab lurks during the day in appropriate nooks near high tide mark. On July 1 ten specimens (diam. : 13·5-29·5 mm. ; ave. : 21·4 mm.) were examined. The food contents consisted of a beetle, 1·7 ; plants, 90 ; mud, 8·3. No parasites.

Paratelphusa (Paratelphusa) spinigera (Wood-Mason).

Ten of these crabs (diam. : 22-49 mm. ; ave. : 39·4 mm.) were collected from a pond about a mile from the river among rice fields. The pond contained many water hyacinths. Food : vegetation, 97 ; mud, 3. Encysted trematodes (80 : 48·8) occurred in the gills and among the viscera ; rotifers (30 :) were present in the branchial cavity.

Varuna litterata (Fabricius).

Eight specimens of this crab (diam. : 20-27 mm. ; ave. : 23·1 mm.) were taken from a pond in a rice field about a mile from the river on July 4. These contained only remains of vegetation as food, and no parasites.

DESCRIPTION OF NEW PARASITES.

PROTOZOA.

Trypanosoma saccobranchi, sp. nov.

Body : slender, sinuous (Fig. 2) ; length : 0·036 mm. ; width : 0·0017 mm. Length of trophonucleus : 0·005 mm. ; parabasal body : 0·002 mm. The parabasal body is very close to the posterior end of the body and far (0·02 mm.) from the trophonucleus. The flagellum is about 0·013 mm. long ; slender ; gradually tapering. The vibratile membrane is narrow. When alive on a slide these trypanosomes are very active.

Host : *Saccobranchus fossilis* (Bloch) ; Collected near Calcutta, India ; July 14, 1930. Indian Museum, Reg. No. P950.

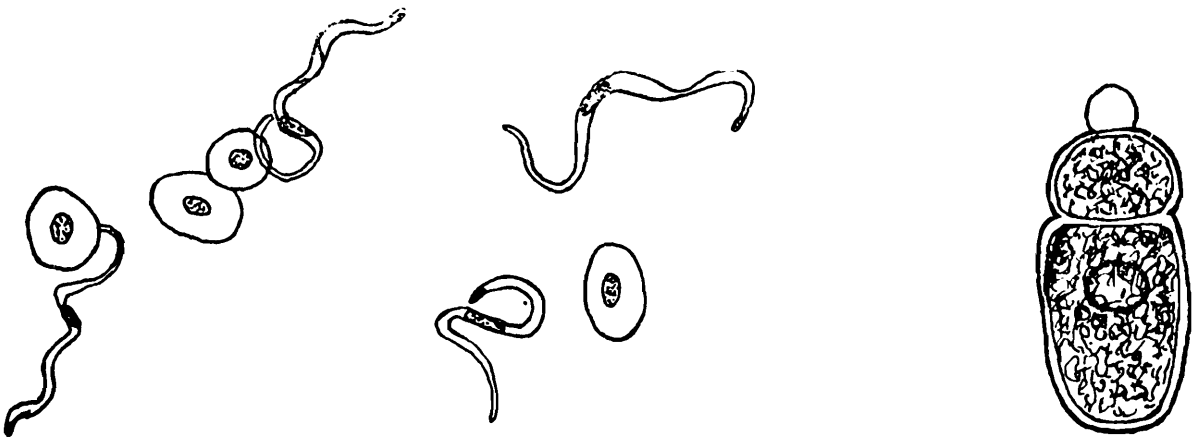

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FIG. 2.—*Trypanosoma saccobranchi* and blood corpuscles from *Saccobranchus fossilis* ; from a preparation stained with Giemsa.

FIG. 3.—*Steinina metaplaxi* from *Metaplax dentipes.*

Steinina metaplaxi, sp. nov.

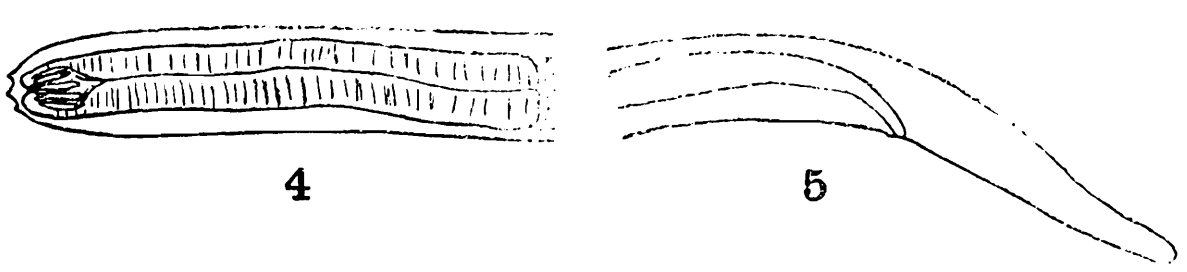
Body (Fig. 3) : robust, somewhat flattened ; length : 0·04-0·06 mm. ; width : 0·018-0·02 mm. Nucleus ellipsoidal, longest across body ; 0·006 × 0·007 mm. The epimerite in resting condition is nearly spherical ; diameter : 0·005 mm. The protomerite is wider (0·016 mm.) than long (0·01 mm.) and rounded anteriorly. The deutomerite is rectangular, with rounded angles, 0·025 mm. long and 0·018 mm. wide. The nucleus is situated about at the end of the anterior third of the deutomerite, though it varies somewhat in position in different individuals. Around the protomerite and the deutomerite is a heavy pellicle. Syzygy apparently does not occur.

Host : *Metaplax dentipes* Heller ; in intestine. Port Canning, India July 1, 1930. This genus has previously been reported only from beetles.

NEMATOIDEA.

Rhabdochona uca, sp. nov.

Spiruroidea ; *Thelazidae.* Body length of female (Figs. 4, 5) : 1·2 mm. ; width : 0·03 mm. Lips with three teeth ; buccal cavity supported by eight longitudinal thickenings ; muscular esophagus, 0·24 mm. long ; glandular esophagus, 0·22 mm. long. Tail : 0·14 mm. long ; tapering,



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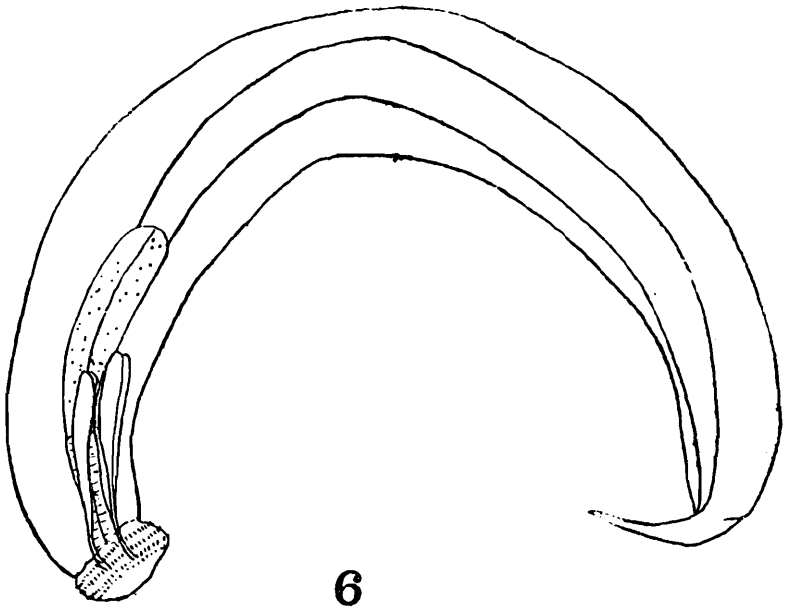
FIGS. 4, 5.—*Rhabdochona uca* ; anterior and posterior ends of female.

obtuse. Uteri apparently opposed ; anterior one showing eggs increasing in size posteriorly ; vulva near middle of body. Three specimens of this intestinal worm were collected, but two were accidentally lost. Until males are known the species is tentatively assigned to the genus *Rhabdochona*.

Host : *Uca manii* Rathbun ; Port Canning, India. July 1, 1930. Indian Museum, Reg. No. W 1666/1.

Gnathosotoma juv.

One specimen (Figs. 6, 7) of a worm belonging to this genus was taken from a cyst in the mesentery of *Saccobranchus fossilis* (Bloch) ; Calcutta, July 14, 1930. Length of body : 3·72 mm. ; diameter, 0·40 ; length of tail : 0·55 mm. ; tapering, acute. The lateral lips are indistinctly trilobed. The body bears about 211 girdles of spines, which gradually decrease in size posteriorly. The head bulb bears four rows of spines which from anterior to posterior contain the following numbers : 34, 42, 48, 52. Ballonets, slender ; 0·6 mm. long. Muscular esophagus, 0·4 mm. long ; glandular esophagus, 0·65 mm. long. The adult stage of this worm may be found in some fish-eating vertebrate. Indian Museum, Reg. No. W 1667/1.



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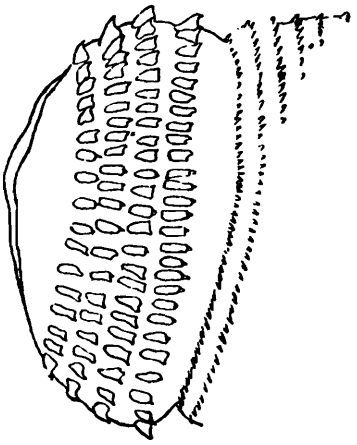

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FIGS. 6, 7.—*Gnathostoma* juv. ; body and enlarged view of anterior end.

DISCUSSION AND CONCLUSIONS.

To those who are interested in the transformations which permit animals to change their daily activities from sea to fresh-water or from aquatic to terrestrial habits, the Ganges Delta is an inspiring observation ground. The heavy rainfall, high tides and extensive tide-water areas, enormous body of water, monotonous soil, and high temperatures make a setting which offers unique opportunities for scientific work. Several talented investigators, such as Kemp, Alcock, and Annandale, have already studied the animals in the Delta and have written some excellent papers. Pelseneer (1906) and others long ago pointed out that the whole

Bay of Bengal is diluted by heavy rains and that animals there are becoming gradually adjusted to fresh water. But Annandale (1922) was surprised when he observed how often invaders from the ocean were turned back when they had their chance to invade freshwater habitats during the rainy season ; and, though the brackish waters of the delta were chiefly populated by typically marine animals, how few of these actually became established in freshwater. The invasion of freshwater from the sea is a slow, hard fought struggle. Annandale specifically mentioned a crab, *Varuna litterata*, as a species which was continually unsuccessful in such attempts to establish itself. The writer found adults of this species in a pool in the midst of a rice field, about a mile from the river. This one little colony had apparently won its battle and attained freshwater.

At Port Canning the writer had opportunity to study the foods and parasites of certain littoral crabs and fishes. Some of these are aquatic, estuarine types, some are adjusted to life in freshwater or on land, and some are amphibious types which at times wander over the land or are intermittently exposed to different media on account of fluctuating tides or floods. A few generalizations may perhaps be justified.

In regard to foods, it was at once apparent that the five species of fishes which were studied ate a far greater variety of foods than the eight species of crabs (17 : 7). Crabs ate more of plants (60·89 : 14·16) and of mud (34·40 : 12·10) than fishes. About two-thirds of the food of the crabs studied consisted of vegetation and the other third was mud ; the amounts of other foods was quite negligible. The shore crabs ate most of the mud ; those (*Varuna*, *Paratelphusa*) which lived in ponds away from the river ate little or none.

The crabs showed a better segregation into habitats than the fishes. Along the beaches they were more definitely arranged in zones, and they thus avoided interspecific competition. Though different species of fishes were often associated in the same habitats as the waters along the beaches rose and fell, they were not competing for foods to any extent. This was perhaps because they were more specialized than crabs in their food habits. Often the food of a fish may be surmised if one knows the length of its intestine. As is well known, vegetarians commonly have long intestines and carnivores have short intestines. The fishes observed at Port Canning may be arranged in the following order, according to the length of the intestine in relation to length of the body : *Aprocryptes lanceolatus*, 3·43 ; *Aoria gulia* 1·00 ; *Periophthalmus cantonensis pearsei*, 0·76 ; *Saccobranchus fossilis*, and *Taenioides rubicundus*, 0·70 ; *Ophicephalus striatus*, 0·69 ; and *Glossogobius giurus*, 0·38. The first species subsists largely on algae and the last is a fish eater.

The parasites which occur in the fishes and crabs at Port Canning are more difficult to discuss than the foods. In general there are more parasites associated with fishes than with crabs. This is perhaps correlated with the fact that fishes have larger bodies and more nutritious internal fluids. There are on the whole more parasites in aquatic than in land fishes. Some types of parasites are wholly absent from the latter ; *i.e.*, trematode cysts, nematode cysts, and acanthocephalans.

Land crabs at Port Canning have about as many parasites as those which live in water. This agrees with observations which the writer made in a great estuary in Siam (Pearse, 1932), but does not support those made farther north on the Asiatic coast (Pearse, 1930, 1931) at Foochow, China and Misaki, Japan. At the latter localities land crabs were found to have more parasites than aquatic crabs. Mites and copepods were commonly found on the gills of land crabs, but such parasites were not observed in Siam or India. The following parasites and commensals were found associated with only one species of host: *Epistylis* (*Uca*), *Stelina* and intestinal ciliates (*Sesarma*), rotifers (*Paratelphusa*), *Dichelaspis* (*Scylla*), *Leidya* (*Metaplax*), and *Trypanosoma* (*Ophicephalus*) and certain other parasites in fishes. Encysted nematodes were found in fishes and not in crabs. Copepods were found only on the gills of fishes. Trematode cysts occurred in several species of fishes and crabs. Of course it is not possible to generalize on the occurrence of the parasites of the crabs and fishes studied when little is known about secondary hosts, habitats, host specificies, life cycles, and other factors.

At Port Canning the crabs and fishes which live in the tidal zone or have attained life in freshwater or on land have arrived at their present habitats by gradually spreading from the ocean. Such long migrations may have involved circuitous biways in some cases. For example, bony fishes apparently originated in freshwater from more remote ancestors (Barrell, 1916; Case, 1919). The crabs which have left the estuary are vegetarians. The fishes which have become best adjusted to land life are largely eaters of arthropods; from crustaceans in the water they have turned to insects on land. Of course the land vegetation is a better source of nourishment than that which grows in water. Animals which leave the stable, dependable ocean and through long ages travel the hard route to land encounter new dangers, escape old enemies, find new difficulties which require new adjustments, and attain new rewards. Land animals eat more nutritious foods, live and move faster, depend more on sense organs which are concerned with distance perception, and reach higher psychic levels than their more primitive aquatic relatives. They have not attained these rewards by planning and striving for them. The oxygen lure, the speed lure, the breeding lure, the food lure, or the safety lure did not bring them on land; though any of these may be a contributing factor. Apparently the most important factor is habitatic segregation—the avoidance of competition by invading unused areas (Pearse, 1929). In the Ganges Delta and in many other parts of the earth animals are progressing toward land to-day.

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TABLE I.

Air temperatures and humidities at Port Canning. With one exception[1] observations were made on the porch of the rest house about 15 feet above the ground.

Date, July.	Time.	Temp., °F.	Humidity.	Conditions.
1	12-30 P.M.	86·0		
	3-20 P.M.	88·4	73	Wind ; sun and showers.
	7-30 P.M.	83·3	86	Wind.
2	7-30 A.M.	83·0	86	Scattered clouds.
4	3-30 P.M.	87·3	72	Cloudy ; previously, showers.
5	2-40 P.M.	89·5	74	Scattered clouds.
6	2-25 P.M.	87·7	83	Thunder clouds.
	2-40 P.M.	85·6	73	Strong wind.
	3-35 P.M.	79·7	91	Wind ; rain.
	5-20 P.M.	79·6	90	Wind ; rain.
	6-00 P.M.	79·0	85	Rain wind ; rain.
7	8-15 P.M.	79·5	88	Cloudy —.
	8-25 P.M.	79·2[1]	91[1]	Cloudy + On ground by pond.

TABLE II.

Temperatures of water in goby pools at Port Canning, July 7, between the levee and the river.

Time, P.M.	Size of pool; ft.	Depth; inches.	Temp., °C.
2-35	4×10	1	27·15
2-40	4×10	2	27·30
2-43	8×12	3	27·20
2-45	6×10	0·5	27·20
2-48	3×25	0·5	28·90
2·55	5×18	0·75	28·30
2-57	5×18	2	27·70 in bottom mud.
2-59	Stream.	1	27·40
3-10	200×100	18	27·50
3-21	50×300	36	27·90