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Studies on the biotaxonomy, biology and ecology of some longicorn beetle borers (Coleoptera : Cerambycidae) of the Islands of Andaman, India

by

T. N. KHAN
P. K. MAITI

Issued by the Director
Zoological Survey of India, Calcutta

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CONTENTS

STUDIES ON THE BIOTAXONOMY, BIOLOGY AND ECOLOGY OF SOME LONGICORN BEETLE BORERS (COLEOPTERA : CERAMBYCIDAE) OF THE ISLANDS OF ANDAMAN, INDIA

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INTRODUCTION

The characteristic tropical climate of the islands of Andaman in the Bay of Bengal, supports a wide variety of timber yielding plants, which provide unique habitats to numerous timber pests belonging to different orders of insects. These insects particularly in their larval stage cause considerable damage to the wood in its varied forms, in the forest stands, at the timber extraction and logging centres and timber depots, in the wood-based industries and to a variety of wood in human services. Amongst these insects, cerambycids or longicorn beetles occupy a dominant positon so far as their economic importance is concerned. It is well known that the cerambycids are in their greatest abundance in all the tropical insular land masses of the world (Gressitt, 1961).

However, the progress of research on the economic status, biological peculiarities and environmental relationships of these important pests does not at all commensurate with the economic importance of the group occuring in the islands of Andaman.

Keeping this in view, a special project on the "Ecological interaction and economic status of the xylophagous insects of the islands of Andaman and Nicobar" was undertaken from August 1978, under the guidance of one of us (P.K.M.). The present communication is mainly based on the data collected through the field and laboratory studies on some of the most important borers of these islands.

Our knowledge on the bioecology of cerambycids of the Andaman islands is very poor although more than 100 species have already been recorded from the area by different authors (Gahan, 1906 ; Stebbing, 1914 ; Beeson, 1919b ; Beeson and Bhatia, 1939 ; Breuning, 1935, 1936, 1938, 1939, 1957, 1960 and 1974).

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* Junior Research Fellow attached to the above mentioned project.

Though the work is still in progress, this preliminary record deals with the biology of some 30 species with particular reference to their economic status, host-range, phase and duration of larval development pattern of gallery formation and chambers, feeding and sexual behaviour, emergence and longivity of the adults, etc. Moreover, some features of biological manifestations especially the patterns of the larval gallery and pupal chamber formation have been used to formulate a key for the identity of the borers infesting the wood. In addition, ecological aspects of some common and economically important species have been taken into account with regard to their host-preference, frequency of infestation, abundance, population intensity, cumulative depth of penetration, etc., in relation to the changing conditions of different hosts influenced by progressive drying and decaying.

It is well known that these insects maintain their dest ructive existence due to their characteristic biological features and unique ecological adjustment with the biotic and abiotic factors within the micro-habitat inside the wood. For any control measure of these noxious insects, there is an urgent need to investigate the important key factors influencing the survival potentiality of these borers. Keeping this in view, the present work has been devoted to enumerate the bioecological interference of these insects to the wood, manipulation of which may provide an insight into the strategy of their management.

All the distributional records of the species have been considered first record, since the earlier records are broadly referred to the island itself without attributing any specific locality.

However, any bioecological study on these insects cannot be fully understood, if the physiography, climate, vegetation, etc., of the area are not taken into consideration. Hence, a brief account of these features has also been incorporated in the present contribution.

PHYSIOGRAPHY, CLIMATE, FOREST, ETC.

The islands of Andaman and Nicobar are actually the exposed portions of a long submarine mountain chain in the Bay of Bengal, 1125.6 km. long, running from cape Negrais in continuation with the Arakan Yomah Range of Burma in the north and Metawaii group of Sumatra in the south. About 324 islands in the north constitute the Andaman group covering an area of about 6332 sq. km. The Andaman group of islands are situated between latitudes10°30′ and 13°41′ N. and lcngitude 92°11′ and 93°07′ E.. These islands form a mass of hills

enclosing narrow valleys and 75 per cent of the territory is covered with dense tropical forests in which the evergreen trees are dominating. Saddle Peak (732 m) is the highest point in the North Andaman.

Like that of the other tropical islands on the same latitude, the climate is warm and humid. The mean temperature near the sea-level ranges between 21°C (January) and 30°C (May) and the maximum diurnal range is 10.8°C. The relative humidity varies from 66% to 93%, being the maximum during the months of from May to November. The rainfall varies from 228.5 to 342.9 cm per year under the influence of both the South-West (May to September) and North-East (October to December) monsoons and January and April are the dry months. Cyclones occur at the changes of monsoon and are rare.

The soil varies from sandy to heavy clayey loam towards further inland. Some of the shores support rich growths of mangroves and coral reefs of the fringing type. The islands first arose in the ocean bed during the Cretaceous period (c. 110 million years ago) of the Mesozoic Era, after which they underwent elevations and partial submergence several times (Karunakaran, 1962). The vegetation of these islands is mostly of the Burmese type. The lush and luxuriant forest growth in these islands yielding more than fifty valuable timbers of quality and high yield, is the most important natural wealth of these islands.

HISTORY

Our knowledge on the biology and ecology of the cerambycid-borers inhabiting the Indian subcontinent is certainly poor in considering the enormous scope of studying the vast magnitude of fauna of great economic importance. For the existing knowledge, the entire credit goes to the work of Beeson and Bhatia (1939) which first dealt with some 350 species from the Indian region. Only some 34 species have been dealt with in greater details of biological features, while the others are limited to the distribution, duration of life-cycle, emergence period, etc. Further works, worthy of mention in this regard, are those of Stebbing (1905, 1906 and 1914), Beeson (1919a, 1919b, 1919c, 1919d, 1921, 1924, 1925, 1930, 3931, 1935 and 1941), Husian and Khan (1941), Bhasin and Roonwal (1954), Bhasin, *et al.* (1958), Dutt (1961) and others.

However, more than one hundred species have so far been recorded from the islands of Andaman, but no attempt has yet been made to study the bioecological criteria of these species in the insular environment of the Andamans. Only some 30 species have been included in the biological

contributions of Beeson and Bhatia (1939) and Beeson (1941), of which some ten are endemic to these islands, while the rest have a wide distribution including the mainland of India. The major biological information available on the widely distributed species are mainly based on the observation made in the mainland of India with very limited information on the host-range, adult emergence, etc., from the islands of Andaman. Recently, Khan and Maiti (1981 1982a and 1982b) have dealt with the detailed account of the bionomics and life-history, and life and fecundity tables of *Olenecamptus bilobus* (Fabricius) and the host-selection, oviposition and fecundity of *Acalolepta rusticator* (Fabricius) from the islands of Andaman. Thus, the present authors have already initiated and have been continuing the work on the bioecology of these borers, some results of which are included in the present communication, while the rest is being compiled to be published elsewhere.

MATERIAL AND METHODS

Field and Insectary Studies

The present monograph is based on the studies and collection of cerambycid-borers from the different islands of Andaman during the last three years. Extensive collections were made from numerous localities from Diglipur in the North to Chidyatapu in the South Andaman and from Little Andaman, while intensive observations were made in different localities, namely, Garacharma, Guptapara, Dhanikhari, Wandur, NewWandur, Panighat and Kaddalgunj, all around Port Blair, South Andaman. In addition, studies were also carried out in different forest areas, timber extraction and logging centres, timber depots, wood-based industries, etc. The general biological features, such as, oviposition, nature of larval galleries and mines, pupal chamber, symptom and extent of damage, host-range and specificity, imaginal behaviour and other relevant data were kept in regular record.

In order to determine the frequency of infestation by different borers to some logs of commercial importance, some extraction and logging centrers in the Middle and South Andaman were kept under constant observations. The percentage of each host-log present in a particular centre was determined first and subsequently, percentage of infestation to each species of logs attacked by different borers was calculated. The age of the felled logs was kept in record usually being ascertained from the personnels of the Forest Department. For

the estimation of the density of larval populations per log or tree, samples were taken at random from serval unit-areas of 25 cm × 25 cm of different hosts.

Insectary studies were conducted at Port Blair, South Andaman, using infested materials collected from several field sites. The infested logs, branches or portions of trees were kept in spaceous galvanized iron chembers (70 cm × 37 cm × 37 cm). They were examined each day uniformly between 1000 and 1100 hours IST. The newly emerged adults were collected each day uniformly between 900 and 1000 hours IST.

Identification of the Immature stages

The preliminary identification of the immature stages collected from the field sites was made using the descriptions and key to the immature stages of Indian Cerambycidae devised by Gardner (1925, 1927, 1930, 1931a and 1931b) and Duffy (1968). Although, these descriptions and keys were useful in making tentative identification, a considerable number of the species concerned with the present study was not included in them. The identification of those species, as well as, the confirmation of identification of all the species encountered in this study, were made possible by rearing and breeding of the insectary emerged beetles in the laboratory. Mating and oviposition occured, and thus the larvae and pupae were obtained that could be related to identified adults.

Laboratory Breeding

Laboratory breeding studies were carried out using the insectary emerged adult beetles. They were sexed and kept in pairs in the breeding-jars, made of glass (37 cm × 22 cm × 22 cm), containing a layer of moistened sandy soil at the bottom. The beetles were provided with freshly cut logs of respective host-plants for oviposition and fresh green leaves, tender branches and twigs, pollen grain containing fresh Androesium, different flower parts, etc., of a number of plants including the larval hosts for food. All these supplies were renewed at regular intervals. The egg-bearing logs, thus obtained from the breeding-jars, were kept in separate cages and were examined at regular intervals until the adult emergence. Samples from all the batches were also taken at regular intervals.

Determination of Larval Instars

The number of larval instars in most of the species was determined directly from the sample larvae which were taken at regular

intervals from the laboratory bred materials. The exuvae, particularly the head-capsule of the earlier instar, offered the confident clue of each moult. For the easier determination of the number of larval instars in the field populations, the following method was adopted : For each species, the average width and the range of variation of the head-capsule of the different larval instars of laboratory bred populations were determined and 'Dyar's Law' was applied which seemed to be fitting in the study of cerambycid-beetles (Duffy, 1946 ; Tapley, 1960 and Khan and Maiti 1982 b). The resulting ratio of growth was then applied to the larvae collected from the field sites and the number of larval instars in the field populations was determined accordingly. However, in the cases of some species where the larval instars could not be determined directly, the number was ascertained solely applying the 'Dyar's Law'.

Emergence and Behaviour of the Adult Beetles

Observations on the emergence, food and feeding habits, mating and oviposition behaviour and the other relevant habits of the adult beetles were made in the field sites throughout the study period and were supplemented by more detailed observations made in the insectaries, as well as, in the laboratory.

BIOTAXONOMIC STUDY

It is well known that the shape, size, location and orientation of the pupal chamber of the cerambycid-borers in their wood habitats are characteristics of each species. But, under certain abnormal circumstances, the larva may modify the location and orientation of the pupal chamber (Beeson and Bhatia, 1939). However, It has been observed in the present study that the characteristic features of the larval galleries and pupal chamber maintain a considerable uniformity with some minor variations in the majority of the species, which has certainly provided material for the formulation of a key for the recognition of the species based on the larval habitats. The taxonomic key, beyond doubt, is an authentic aid to the confident identification of the borer species. However, it is hoped that the present key will serve the purpose of recognising the species in the field itself, particularly in the case, where the adults have already escaped from the infested logs or trees leaving behind the characteristic galleries and chambers made by the larvae.

1(8). **Pupal chamber with calcareous deposition, either lining the chamber in the form of cocoon or closing the opening in the form of operculum.**

2(3). Pupal chamber with 'Gandhi Cap' like calcareous operculum placed at the opening .. *Aeolesthes* (*s. str*) *holosericea* (Fabr.)

3(2). Pupal chamber with calcareous cocoon placed in the middle.

4(5). Pupal chamber usually placed inside the heart-wood, large, with egg-shaped, thick walled calcareous cocoon (Pupal chamber placed inside the sap-wood or even under the bark, but, egg-shaped, thick walled calcareous cocoon always present) .. .. *Plocaederus obesus* Gahan

5(4). Pupal chamber always inside the sap-wood small, with Capsule shaped, thin walled calcareous cocoon (a portion of the chamber, placed inside the superficial layer of heart-wood, but Capsule-shaped, thin walled calcareous cocoon always present) *Xystrocera globosa* (Olivier)

6(1). Pupal chamber without any calcareous depositions.

7(12). Pupal chamber large usually placed deep inside the wood, with a separate exit-hole originating from the opposite end of the entrance--hole.

8(9). Pupal chamber never extending beyond 11 cm inside the wood, comparatively smaller, measuring. 6.5—8.9 cm in length and 4.1—5.1 cm in breadth .. *Batocera rufomaculata* var. *andamana* Thoms.

9(8). Pupal chamber always extending beyond 11 cm inside the wood, robust, measuring 10.0-14.9 cm in length and 6.5—8.5 cm in breadth.

10(11). Pupal chamber occuring only in the logs of *Dipterocarpus* species, never in the soft woods *Rhaphipodus* (*Remphan*) *hopei* (Waterh.)

11(10). Pupal chamber occuring only in the soft woods, never in *Dipterocarpus* species .. .. *Rhaphipodus* (*s. str.*) *andamanicus* Gah.

12(7). Pupal chamber small, placed inside the sap-wood or under bark, with or without a separate exit-hole.

13(26). pupal chamber without a separate exit-hole, originating from the opposite end of the entrance-hole.

14(19). Pupal chamber always with an extra larval tunnel more or less at right angles to the main axis of the chamber.

15(18). Pupal chamber with an extra larval tunnel directed upwards or downwards or both ways, only at the entrance, giving the whole structure either 'L' or 'T' shaped appearence.

16(17). Pupal chamber with the extra larval tunnel directed either upwards or downwards, thus giving the whole structure a 'L'-shaped appearance .. .. *Ceresium genieulatum* White

17(16]. Pupal chamber with the extra larval tunnel directed both upwards and downwards, thus giving the whole structure a 'T'-shaped appearence. .. .. *Ceresium flavipes* (Fabr.)

18(15). Pupal chamber with extra larval tunnels directed upwards and downwards on both the entrance and distal ends of the chamber giving the whole an 'I'-shaped appearence. *Ceresium andamanicum* Gah.

19(14). Pupal chamber normal, without any extra larval tunnel.

20(21). Pupal chamber usually vertical (rarely parallel) to the wood fibres, larval galleries always packed tightly with fine powdery frass. .. . .. *Halme caerulescens* Gah.

21(20). Pupal chamber usually parallel (rarely oblique) to the wood fibres, larval galleries always packed with fibrous frass.

22(25). Pupal chamber comparatively shorter, never exceeds 1.6 cm in length and 0.7 cm in breadth,

23(24). Pupal chamber always less than 1.0cm in length and 0 5 cm in breadth. .. .. .. *Xenolea tomentosa* (Pasc.)

24(23). Pupal chamber always more than 1.0 cm in length and 0.5 cm in breadth . .. .. *Serixia (s. str.) andamanica* Gard.

25(22). Pupal chamber compartively larger always more than 2.0 cm in length and 0.8 cm in breadth. .. *Glenea (Stiroglenea) andamanica* Breun.

26(13). Pupal chamber with a separate exit-hole, originating from the opposite end of the entrance-hole.

27(44). Pupal chamber usually confined inside the sap-wood (rarely under the bark) and always elogated in shape.

28(37). Pupal chamber broad, more than 1.4 cm in width ; exit-hole always more than 0.8 cm in diameter.

29(30). Pupal chamber with exit-hole commencing slightly before the distal end of the chamber, ... *Epepeotes* sp.

30(29). Pupal chamber with exit-hole commencing right at the distal end.

31(36). Pupal chamber comparatively larger, always more than 5.3 cm in length and 1.5 cm in breadth ; exit-hole always more than 0.9 cm in diameter,

32(35). Pupal chamber strictly confined to the sap-wood, larval galleries packed with fibrous frass and short larval tunnel leading to the pupal chamber.

33(34). Pupal chamber always more than 6.6 cm in length and 2.2 cm in breadth ; exit-hole always more than 1.5 cm in diameter. .. .. *Pharsalia* (*Cycos*) *subgemmata* (Thomson)

34(33). Pupal chamber usually less than 6.6 cm in length and 2.2 cm in breadth ; exit-hole not more than 1.5 cm in diameter. *Acalolepta andamanica* (Breuning)

35(32). Pupal chamber at various depths in wood, larval galleries packed tightly with fine powdery frass and long larval tunnel leading to the pupal chamber *Stromatium barbatum* (Fabricius)

36(31). Pupal chamber comparatively smaller, usually less than 5.3 cm in length and 1.5 cm in breadth ; exit-hole always less than 0.9 cm in diameter .. *Acalolepta rusticator* (Fabricius)

37(28). Pupal chamber narrow, usually less than 1.4 cm in width ; exit-hole not more than 0.8 cm in diamete.

38(39). Larval galleries usually packed tightly with fine floury frass .. .. *Xylotrechus buqueti* (Laporte & Gory)

39(38). Larval galleries usually packed tightly with fibrous frass.

40(43). Pupal chamber not more than 2.0 cm in length.

41(42) Pupal chamber always more than 1.2 cm in length and 0.5 cm in breadth .. .. *Acalolepta admixta* (Gahan)

42(41). Pupal chamber tiny, not more than 1.0 cm in length and 0.5 cm in breadth. .. .. *Exoecentrus* (*Camptomyme*) *aboscutellaris* Breuning

43(40). Pupal chamber usually more than 2.0 cm in length (usual range 2.0-3.10 cm) .. .. *Olenecamptus bilobus* (Fabricius)

44(27). Pupal chamber usually in or under the bark (rarely in the sap-wood) and always ovoid in shape.

45(58). Larval galleries usually packed with fibrous frass.

46(53). Pupal chamber broad, more than 1.0 cm in breadth and usually situated between 0.4-2.0 cm depth, larval galleries weakly marked on the sap-wood surface.

47(52). Pupal chamber usually more than 1.4 cm in breadth, larval excavation closer to the sap-wood and running at a depth of more than 0.6 cm, exit-hole always more than 0.9 cm in diameter.

48(49). Pupal chamber always more than 2.0 cm in breadth, situated deeper than 1.2 cm ; exit-hole always more than 1.2 cm in diameter. .. .. . *Coptops rufa* Thomson

49(48). Pupal chamber always less than 2.0 cm in breadth, situated above 1.2 cm depth ; exit-hole less than 1.2 cm in diameter.

50(51). Pupal chamber situated superficially at a depth of 0.8 cm and its walls formed by bark or wood fibres in such a fashion that the whole structure has a 'Bird's nest' like appearence .. .. .. *Clyzomedus annularis* Pascoe

51(50). Pupal chamber situated below 0.8 cm depth and never constructed in ihe shape of a 'Bird's nest'. . *Mispila* (s. *str.*) *venosa* m. *augularis* Pascoe

52(47). Pupal chamber less than 1.4 cm in breadth, larval excavations more in the superficial surface of sap-wood and usually running at a depth of less than 0.6 cm ; exit-hole less than 0.9 cm in diamter. .. *Pterolophia* (*s. str.*) *pallidifrons* Breuning

53(46). Pupal chamber narrow, less than 0.6 cm in breadth and not exceeding 0.4 cm in depth.

54(55). Pupal chamber exclusively in the bark and not more than 0.40 cm in width .. *Ropica honesta* m. *rufescens* Pic

55(54). Pupal chamber under the bark, in shallow excavation on sap-wood surface and more than 0.40 cm in width.

56(57). Pupal chamber comparatively larger more than 0.56 cm in length and 0.41 cm in width, situated exclusively under the bark and typically 'Bird's nest' like. *Pterotophia* (*s. str.*) *sterculiae* Breuning

57(56) Pupal chamber comparatively smaller, less than 0.65 cm in length and 0.41 cm in width, situated in shallow depression on sap-wood surface and roughly 'Bird's nest' like *Pterolophia* (*s. str.*) *andamanica* Breuning

58(45) Larval galleries are packed tightly with fine granular frass *Desisa* (*Cylindrostyrax*) *marmorata* Breuning

BIOLOGICAL OBSERVATIONS

This chapter is primarily devoted to the basic biological eharacteristics of the cerambycid-borers of the islands of Andaman. A reasonable amount of information has been collected for each species starting from oviposition to death of the adults, based on detailed observations made both in the field and in the laboratory. In recording such data, special emphasis has been given to some of the most vital aspects of their life processes, particularly as regards the host-range and specificity, development and feeding activities of the larvae, and reproductive strategies and behavioural aspects of the adults. In addition, each species has been furnished with a brief synonymy, distribution, economic importance, etc., to make the present contribution a self-contained volume.

All the borer species have been arranged according to the recent taxonomic classification of this group adopted by Gressitt and Rondon (1970) and Rondon and Breuning (1970).

FAMILY : CERAMBYCIDAE

SUBFAMILY (i) : PRIONINAE

The deep boring prionine beetles appear to be the most destructive pests in the timber extraction coupes, logging centres and timber depots of these islands. Only two species of this subfamily have been studied in the present endeavour with regard to their biology. Therefore, no generalization of their biological and behavioural feature could be made. However, both the species, represented by nearly equal sex-ratios of approximately 1 : 1, oviposit under the bark and the mature larvae mine deep inside the wood. The detailed biology of these two species is as follows :

1. **Rhaphipodus (s. str.) andamanicus** Gahan

(Plate—I, figure—A)

Rhaphipodus andamanicus Gahan, 1898. *Ann. Mag. nat. Hist.*, **14**(6) : 224.
Type-locality : Andaman islands ; Gahan, 1906. *Fauna Brit. India.* (Col.), **1** : 33.

Distribution :— ANDAMANS : *South Andaman* : Guptapara, New Wandur, Baratang island and Peel island (all present records).

ELSEWHERE : None.

The prionine species, *Rhaphipodus* (*s. str.*) *andamanicus*, is one of the largest cerambycid-borers found in the islands of Andaman, measuring 5.0 - 7.0 cm in length and solely distributed in this area. No biological information was available on the species, until it was studied on a number of occasions in the course of the present study, infesting comparatively larger logs of the following timber yielding species : ***Parishia insignis***, ***Pterocymbium tinctorium***, ***Salmalia insignis*** and ***Salmalia malabarica***.

The female usually oviposits her eggs singly or in batches of 2-5 under the bark of the dead felled logs. After an incubation period of 6-9 days, the newly hatched larvae bore down gradually to the deeper layers of the wood excavating more or less transverse tunnels. With the progressive age, the larvae excavate closely crowded irregular tunnels, packed with a coarse fibrous frass, extending even upto the pith of the wood. The larval mines are very large, ranging from 6.4 to 12.0 cm in width and the larvae pass through six instars within a time span of 6-8 months. The pupal chamber is constructed at various depths from about 15 cm below the wood surface to deep inside upto almost near the pith, depending upon the physical condition of the host. The pupal chamber ranges from 10.0 to 13.6 cm in length and 6.5 to 7.2 cm in width. The pupal period usually varies between 1 and 2 month. After spending 3 to 4 weeks as a dormant adult, the mature beetle emerges by chewing through the distal end of the pupal chamber leading to a more or less circular exit-hole of 2.73 to 3.16 cm in diameter. The complete development from egg to adult usually requires a period of 8 months to almost a year. However, a small percentage of the progeny in some cases takes 15 months or even more as observed on two occasions at Gupta-para and New Wandur, South Andaman.

Adult emergence occurs almost throughout the year, except, in the months of February and March, and with maximum emergence during the early monsoon months of June and July. The first mating takes place within a few hours after the emergence of adults and oviposition starts after an interval of 4-5 days. Both the mating and oviposition activities are usually displayed during the early morning and late afternoon with maximum frequency at dusk. Food and feeding habits of the adult beetles are not well known, although in a few instances, some adults have been observed to gnaw the tender bark of the larval host-plants. The estimated average adult longevity is 32 days in captivity, while the sex-ratio is 1.2 ♀ : 1♂ both in the natural and laboratory bred populations.

This species is a deep heart-wood borer of considerable economic importance. The larval mines and pupal chambers inside the wood are so extensive and enormous that only a batch of about fifteen larvae is sufficient enough to spoil the commercial value of a log of 3 m. in legth and 1 m. in diameter. However, the species has been found to attack only the dead or dying wood, but it never attacks the live trees in these islands.

2. Rhaphipodus (Remphan) hopei (Waterhouse)
(Plate-I, figures-B-D)

Remphan hopei Waterhouse, 1836. *Trans. ent. Soc. Lond.*, 1 : 67. *Type-locality* : East Indies ; Gahan, 1906. *Fauna Brit. India* (Col.), 1 : 34 : Beeson and Bhatia, 1939. *Indian Forest Rec.* (*N. S.*) *Ent*, 5(1) : 167 (Biology).

Remphan alteni Nonfried, 1891. *Berl. ent. Z.*, 36 : 376.

Rhaphipodus (*Remphan*) *hopei* : Lameeree, 1919. *Genera Insect*, 172 : 55 ; Duffy, 1968. *Imm. Stages Orient. Timb. Beetles*, p. 47 (Larva) : Gressitt and Rondon, 1970. *Pacif. Insects Monogr.*, 24 : 14, fig. 3, e.

Distribution :— ANDAMANS : *North Andaman* : Aerial Bay ; *Middle Andaman* : Bakultala ; *South Andaman* : Kaddalgunj, Baratang island and Peel island and *Little Andaman* : Ramkrishnapur (all present records). ELSEWHERE : Burma, Thailand, Malay Peninsula Kalimastan and Laos.

The robust species, *Rhaphipodus* (*Remphan*) *hopei*, measuring 5.0 to 9.6 cm in length, is rarely found in the Andamans and infests the dead wood of *Dipterocarpus turbinatus*. The biological information on this species is limited to the only record of the above mentioned host-plant and some aspects of larval behaviour, reported by Beeson and Bhatia (1939). The present study indicates that this species also attacks some other species of the genus *Dipterocarpus* in these islands of which *D. turbinatus* seems to be most susceptible.

Although oviposition behaviour has not been directly observed, the inspection of the infested logs has shown that the eggs are apparently laid in groups, since the early larval galleries are usually found radiating from a particular point in the phloem tissue of the logs. The larval tunnels inside the wood run transversely upto a certain depth, after which they traverse along the course of the wood fibres. The tunnels are the largest of all cerambycid-species in these islands, measuring 6.9 to 11.2 cm in width and 1.8 to 2.8 cm in height, and are always packed loosely with coarse fibrous borings (Plate-I, fig. C). The pupal chambers are much larger, measuring 10.7 to 14.9 cm in length and 8.0 to 8.5 cm in cross-section, the distal end of which is holed by the emerging adult beetles leading to an exit-hole of 3.8 to 4.7 cm in diameter.

The mature adults are available throughout the year as stated by Beeson and Bhatia (1939). The maximum emergence of adults occurs during the early monsoon months and is at a minimum during the dry months from January to April.

In order to collect further biological information on this borer, a logging centre at Kaddalgunj, South Andaman, has been kept under constant observation for a period of nine months, i. e., from June, 1979 to February, 1980. About 30% of the logs of *Dipterocarpus* spp. have been found to be infested with the young larvae. No adult or pupa has been collected during the period of observation indicating that the species does not complete its life-cycle within this period.

Present observations reveal that the species is a true heart-wood borer of great economic importance as compared to the other borers recorded so far from these islands. The larval mines inside the wood are so wide, extensive and deep that the economic value of the infested logs is greatly affected.

SUBFAMILY (ii) : CERAMBYCINAE

The cerambycine-longhorns, dealt with in the present communication, exibit a wide range of variations in their biological features. Some are deep-boring species in contrast to many a shallow sap-wood borers. Some of the species oviposit on the bark-surface, others inside the bark and still others under the bark just on the wood-surface. Shape, size and orientation of the larval mines and pupal chambers also vary within wide limits from species to species. The most obvious differences between the species are duration of different developmental stages and total life-span, emergence period, feeding and sexual behaviour, etc. However, all the species exibit a remarkable uniformity in certain major biological features. Among them, the number of larval instars and the adult sex-ratio are worthy of mention. All these species pass through six successive larval instars and are represnted by an overall sex ratio of 1 : 1 in both the field and laboratory-bred populations. However, in most of the species, the adults of some individual cohorts show slight variation from the overall sex-ratio. The biology of all the cerambycine beetles is as follows :

1. Xystrocera globosa (Olivier)

(Plate-II, figures-A-D)

Cerambyx globosa Olivier, 1795. *Entomologist*, **4** : 27, Pl. 12, fig. 81. *Type-locality* : Orient.

Xystrocera globosa : Serville, 1834. *Annls. Soc. ent, Fr.*, **3** : 69 ; Gahan, 1906. *Fauna Brit. India* (Col.), **1** : 106, fig. 42 ; Beeson and Bhatia, 1939. *Indian Forest Rec.* (*N. S.*) *Fnt.*, **5**(1) : 200-201 (biology) ; Gressitt, 1951. *Longicornia*, **2** : 130, Pl. 6, fig. 1 ; Duffy, 1968. *Imm. Stages Orient. Timb. Beetles*, p. 83, figs. 42-43 (immature stages) ; Gressitt and Rondon, 1970. *Pacif. Insects Monogr.*, **24** : 51.

Xystrocera globosa var. *mediovitticollis* Breuning, 1957. *Bull. Inst. fr. Afr. noire*, (A) **19** : 1241.

Distribution :— ANDAMANS : *North Andaman* : Aerial Bay, Diglipur, Lakshmipur, Kshudirampur, Mayabundar and Tugapur ; *Middle Andaman* : Bakultala, Yeretta Jetty, Long Isl. and Kadamtala ; *South Andaman* : Port Blair, School Line, Garacharma, Bidnabad, Terelybad, Shippighat, Dhanikhari, Guptapara, Chidyatapu, Wandur, Bambooflat, Kanyapuram, Wimberlygunj, Kaddalgunj, Ferrargunj, Mathura, Kadakachan, Wright Myo, Rutland Island, Viper Island, Baratang Island, Niel Island, Havelock Island and Peel Island and *Little Andaman* : Hut Bay, Quiary, Penta, Ramkrishnapur and Vivekanandanagar (all present records).

ELSEWHERE : Indian mainland, Bangladesh, Pakistan, Sri Lanka, Burma, Thailand, Malay Peninsula, Laos, Java, China, Japan, Philippines, Celebes, Seychelles, Madagascar, Mauritius and Africa.

Xystrocera globosa, a medium sized species (1.8 to 3.4 cm in length), is fairly well represented in the Orient including the islands of Andaman. The species has so far been recorded from some 12 host-plants in the mainland of India (Beeson and Bhatia, 1939). In the present study, the species with all of its developmental stages has been collected from felled logs of some six host-plants of which *Bauhinia* sp. and *Samanea saman* have been recorded for the first time.

Present observations reveal that the females oviposit in groups of 6 to 10 ova in cracks and crevices or under the scales of the bark. The young larvae after hatching, bore down to the bast excavating irregular galleries which usually radiate in all directions from the oviposition sites. Each of the six larval instars has an average duration of about two weeks. After passing most of the larval life under the bark, the pupating larvae mine into the sap-wood or outer layers of heart-wood, where they pupate in pupal chambers formed parallel to the wood-fibres. Before pupating, the larva returns back to the bark to widen and clean the passage ready for adult emergence. The pre-pupal tunnel and pupal chamber of *X. globosa* are described in detail by Beeson (1941). The pupal chamber usually ranges from 4.7 to 5.6 cm in length and from 0.82 to 0.91 cm in width. Pupation takes place inside a thin layered, calcareous cocoon in the shape of a 'Capsule' which is white in colour with a yellowish tinge throughout. The proximal end (i. e., the end facing the entrance-hole) of the cocoon is usually closed by a thin eiliptical calcareous dome. Pupal duration is not more than two weeks. After passing an average period of 10 days as a dormant adult, the mature beetle emerges through the entrance-hole. Complete development usually requires 4-5 months, although a small percentage of the progeny may take six months or even longer.

Adult emergence takes place almost throughout the year in these islands with its maximum frequency during the monsoon months of July and August. The first mating usually takes place within a couple of hours of adult emergence and oviposition follows after an interval of 4 to 5 days. Mating and oviposition occur during the early morning and late afternoon but may be continued throughout the day specially during cold and cloudy atmospheres. The food and feeding habits of the adult beetles are not well known, although in some instance, the beetles have been found to feed reluctantly on the pollen grains from the fresh androesium. The average adult longevity has been estimated at 25.8 days in the laboratory.

The species has been recorded as an important pest of road-side trees, attacking injured or unhealthy trees and hastening their death. The vigorour trees may be killed in one season by a heavy infestation. *X. globosa* is a well known pest in Malaya and in Egypt and is responsible for the disappearence of *Ablzzia lebbek* in several cities (Beeson & Bhatia, 1939).

2. **Stromatium barbatum** (Fabricius)

Callidium barbatum Fabricius, 1775. *Syst. Ent.*, 189p.

Type-locality : East India.

Callidium funestum Boisduval, 1835. *Voy. d'Astrlabe*, **2** : 481.

Stromatium barbatum : Gahan, 1906. *Fauna Brit. India* (Col,), **1** : 114 ; Beeson and Bhatia, 1939. *Indian Forest Rec. (N. S.) Ent.*, **5** (1) : 174-183 (biology) ; Duffy, 1968. *Imm. Stages Orient. Timb. Beetles*, pp. 120-123 (larva, pupa).

Distribution :— ANDAMANS : *North Andaman* : Aerial Bay, Diglipur and Maybundar ; *Middle Andaman* : Bakultala and Kadamtala ; *South Andaman* : Port Blair, Garacharma, Dhanikhari, Chidyatapu, Wandur, Wimberlygunj, Wright Myo, Baratang Island, Niel Island, Havelock Island and Peel Island and *Little Andaman* : Hut Bay (all present records). ELSEWHERE : Indian mainland, Bangladesh, Pakistan, Sri Lanka, Burma, Islands of Reunion, Rodriguez and Seychelles, Madgascar, Mauritius and Africa.

Stromatium barbatum, a widely distributed species in the Indo-African region, occurs very frequently in the islands of Andaman as indicated in the present study. The species is a well recognized pest infesting mainly the dry and seasoned timbers of as many as 311 host-plants in the Indian region (Beeson and Bhatia, 1939). Among these hosts, some 30 species occur in these islands, of which only 14 species have been recorded in the present study to be infested by this borer.

The eggs are laid singly or in groups of 2-6 in small holes, crack and crevices in the wood (with or without bark) ; in thin battens, planks, plywood and in the fissures formed by imperfect carpenatry joints ; and in rough splintery surfaces of the furniture and other Wood-articles used by human beings. After an incubation period 4 to 11 days (average 7 days), the larvae hatch and bore down to the wood through their excavated galleries. Subsequently, the larvae excavate so irregular and extensive tunnels that the interior wood-mass is reduced to powder, leaving only the outer surface intact. The powdery frass granules, thus produced, are very similar to those of bostrychid beetles. The larvae pupate at various depths inside the wood within pupal chambers of variable shape, size and orientation. However, the typical frss material inside the excessively long pre-pupal tunnel

and the pupal chamber at various depths from the superficial sap-wood to deep heart-wood provide confident clue to their identity. The pupal period is of 12-21 days duration and adults remain dormant for about three weeks before excavating exit-tunnels, leading to semi-circular exit-holes of 0.38 -0.94 cm in diameter, to escape to the exterior. Complete development usually requires 10 to 15 months with an extended period of two years on rare occasions.

Adults emerge during every month of the year in these islands, in contrast to a definite emergence period during the months of May to July on Indian mainland (Besson and Bhatia, 1939). Courtship and mating in the newly emarged beetles follow the same general pattern as in the other cerambycid-beetles already referred to above, while oviposition takes a longer period of 5-6 days after the first mating. Both mating and oviposition occur during the late afternoon hours and attain their maximum frequency during dusk and even continue upto mid-night. Food and feeding habits of the adult beetles are not well-known. The insect is strongly attracted to artificial light. The estimated average span of active imaginal life is 36 days in the laboratory.

The species is of considerable economic importance, not only due to its extremely polyphagous nature, but also because of its preference for seasoned timber (Emden, 1937 ; Saalas, 1939 and Duffy, 1949 and 1968), This borer is perhaps the most dangerous pest of plywood packing cases. *S. barbatum* is also known to infest wooden household articles made up of seasoned timbers, such as, wooden furniture, doors, window-frames, shelves, museum wood specimens, etc. Instances of this species infesting living trees are none. There is a single record of living trees of *Citrus aurantium* being infested by the species (Khare, 1916).

3. **Aeolesthes (s. str.) holosericea** (Fabricius)

(Plate—III, fig. A)

Cerambyx holosericea Fabricius, 1787. *Mant., Ins.*, **1** : 135.
Type-locality : India.

Aeolesthes holosericea : Gahan, 1906. *Fauna Brit. India* (Col.), **1** : 127 ; Beeson and Bhatia, 1939. *Indian Forest Rec. (N. S) Ent.*, **5** (1) : 15-18 (biology) ; Gressitt, 1951. *Longicornia*, **2** : 137 ; Duffy 1968. *Imm. Stages Orient. Timb. Beetles*, p. 99, fig. 51 (larva).

Aeolesthes (s. str.) holosericea : Gressitt and Rondon, 1970. *Pacif. Insects Monogr.*, **24** : 65, fig. 13, a.

Distribution :— ANDAMANS : *North Andaman* : Aerial Bay, Diglipur, Kshudirampur, Lakshmipur and Tugapur ; *Middle Andaman* : Rangat, Bakultala, Long Island and Kadamtala ; *South Andaman* : Port Blair, School Line, Garacharma, Tarelybad, Bidnabad, Shippighat, Dhaikhari, Burmanallah, Chidyatapu, Mungluton, Guptapara, Line Dera, Wandur, Kaddalgunj, Ferrargunj, Mathura, Wimberlygunj, Kadakachan, Wright Myo, Bambooflat, Panighat, Mini Bay, North Bay, Viper Island, Baratang Island, Niel Island, Havelock Island and Peel Island and *Little Andaman* : Hut Bay, Quiary, Penta, Vivekanandanagar and Ramkrishnapur (all present records). ELSEWHERE : Indian mainland, Sri Lanka, Burma, Thailand, Indonesia, Malaysia, Laos, Indo-China, Hainan and South-China.

One of the most polyphagous species, *Aeolesthes (s. str.) holosericea*, is a well recognized pest of felled logs and dead or dying trees in the Oriental region. The species is well represented in the islands of Andaman and recorded on numerous occasions from some 14 host-plants in different localities. Beeson and Bhatia (1939) studied the species in fair detail on the mainland of India with regard to its main biological features.

The females deposit their eggs in batches of 3-8 in cracks and crevices in the bark of recently felled log of dying standing trees. After an incubation period of about a week, the newly hatched larva bores down into the bark to reach the subcortical zone. The larvae excavate irregular galleries in subcortical tissue engraving more on the wood surface than on inner-bark. After feeding in the subcortical tissue for a short period, the sixth-instar larvae mine deep (6.01 to 9.32 cm) inside the wood, leaving the galleries filled with fibrous frass material. The pre-pupal tunnel, in the majority of cases, first runs obliquely, then turns upwards or downwards terminating in a pupal chamber (Plate III, fig. A), which, in most instances, is not vertical as reported by Beeson and Bhatia (1939) in the mainland of India, but forms an angle with the course of wood fibres. Before pupating, the lavrvae return back to the bark to widen and clean the passage ready for adult emergence. The opening of the pupal chamber is closed by a calcareous operculum as already reported by Beeson (1919a, 1941). The estimated duration of the life-cycle of *A. (s. str.) holosericea* on the mainland of India is annual with an extended duration of upto two years (Beeson and Bhatia, 1939). However, it usually takes about

eight months to complete its life-cycle, rarely extending upto 15 months, in these istands.

The premonsoon months, March to May, are the optimum period of adult emergence on the Indian mainland (Beeson and Bhatia, 1939), while the adults emerge throughout the year in the insular environment of the Andamans, with their maximum in the full monsoon (June to August) and minimum in the dry months (December and January). The first mating takes place within a few hours of adult emergence and oviposition follows subsequently after an interval of 4-5 days. Though the species is primarily crepusculur in habit, diurnal feeding and oviposition activities are not uncommon. The beetles show much preference for cool and shady places during the day time. In captivity, the female beetles have been observed to feed reluctantly on some flower parts, particularly on the androecium, of many plants, while males apparently accept nothing, The average adult longevity has been estimated at 30 days under laboratory conditions.

The borer is of considerable economic importance since it ruins the logs in logging centres, timber depots and in the wood based industries very quickly. Though the species is primarily a pest of felled wood, but in some instances it attacks unhealthy standing trees of a number of species, particularly, *Lannea coromandelica* and *Terminalia bellirica*, causing remarkable loss.

4. **Plocaedrus obesus** Gahan

(Plate—III, fig. B and C)

Plocaederus obesus Gahan, 1890. *Ann. Mag. nat, Hist*, **5** (6) ; 51 ; **6** : 250- *Type-locality* : India ; Gahan, 1906. *Fauna Brit. India* (Col.), **1** : 121 ; Beeson and Bhatia, 1939. *Indian Forest Rec.* (*N. S.*) *Ent* **5** (1) : 157 (biology) ; Gressitt, 1951. *Longicornia*, 2 : 141 ; Duffy ; 1968, *Imm. Stages Orient. Timb. Beetles*, p. 114, fig. 59-61 (larva) ; Gressitt and Rondon, 1970. *Pacif. Insects Monogr.*, 24 : 70, fig, 13, i.

Distribution :— ANDAMANS *North Andaman* : Aerial Bay, Diglipur, Kshudirampur, Lakshmipur, Mayabundar and Tugapur ; *Middle Andaman* : Rangat, Lebutala, Bakultala, Yeretta Jetty, Long Island and Kadamtala ; *South Andaman* : Port Blair, School Line, Paharpur, Garacharma, Terelybad, Bidnabad, Shippighat, Dhanikhari, Naya Dera

Mungluton, Burmanallah, Chidyatapu, Guptapara, Line Dera, Wandur, New Wandur, Tushnabad. Rangachan, Ograburj, Kaddalgunj, Ferrargunj, Mathura, Brindaban, Kanyapuram,, Wimberlygunj, Kadakachan, Wright Myo, Bamboofiat, Panighat, Minibay, North Bay, Viper Island, Baratang Island, Niel Island, Havelock Island and Peel Island and *Little Andaman* : Hut Bay, Quiary, South Creek, No. 11 Village, Penta, Vivekanandanagar and Ramkrishnapur (all present records). ELSEWHERE : Indian mainland, Sri Lanka, Burma, Thailand, Laos, Cochin-China and South China.

The cerambycine species, *Plocaederus obesus*, appears to be the most common of all the destructive cerambycid-borers found in the timber extraction and logging centres. timber depots and forest areas throughout the islands of Andaman. The borer is a well recognized pest, with 17 known host-plants from the mainland of India including seven species from these islands (Becson and Bhatia,. 1939). However, in the present study, the species has bren collected for the first time on numerous occasions from the felled logs and dead or dying trees *Artocarpus chaplasha*, *Canarium euphyllum*, *Pterocymbium tinctorium*, *Salmalia insignis*, *Sterculia alata* and *Tetrameles nudiflora*.

The adult beetles are very common in and around the timber extraction centres and timber depots. The eggs are laid singly or in groups of 2 to 5 under the bark, just on the wood surface of dead or dying logs or trees. The incubation period ranges between 5 and 9 days. The newly hatched larvae bore their way into the subcortical tissue and with progressive development, they excavate wide and very irregular gallaries therein which are usually packed tightly with a coarse fibrous frass. In most cases, the infestations are found to be so heavy that the galleries of the adjacent larvae can not be isolated. After a considerable period of feeding on the subcortical tissue, the mature larvae mine deep inside the heart-wood (7.5 to 14.7 cm) where they excavate enormous tunnels which terminate in pupal chambers (Plate—III, fig. B). The duration of the larval life is from 5 to 7 months. Pupation takes place inside a thick walled 'tortoise-egg' shaped calcareous cocoon (Plate-III, figs. B & C) placed in the middle of the pupal chamber, as has been reported by Beeson and Bhatia (1939) as the characteristic features of the species on mainland of India. The pupal chamber ranges from 6.0 to 9.0 cm in length and from 4.4 to 5.7 cm in width. The sides around the cocoon are filled loosely with wood fibres. However, in several instances, particularly in the timber species with thicker bark, the pupal chamber has been found in the sap-wood or even inside shallow (0.30 to 1.09 cm deep) pits under the bark.

It is interesting to note that in these cases the population density has been found to be considerably higher than those where the pupal chamber is confined exclusively to the heart-wood. The pupal period varies from 14 to 20 days with an average of 16 days. After passing an average period of two weeks as a dormant adult, the mature beetle emerges by breaking the cocoon and cleaning its passage through the entrance hole of the larva, i. e., no separate exit-hole is excavated. Complete development usually requires 7 months to almost a year, although under certain circumstances this may extend upto 15 months or even more

Adult emergence occurs throughout the year in these islands with the maximum during June and July and a minimum during the months of January and April. The first mating normally takes place within a few hours of emergence, in the vicinity of emergence, after which the adults disperse in search of suitable host-material. Oviposition follows within 4 to 5 days after the first mating. Both mating and oviposition activities usually occur during dusk and early evening hours and may be continued even throughout the whole night on some occasions. During the day time, the adults have been found resting in cool and shady places. The beetles feed on the bark of a number of plants including the larval hosts. The estimated average adult longevity is 39.6 days under laboratory conditions.

The species is recognised as a true heart-wood borer of considerable economic importance in these islands. In the majority of cases, the species has been found to heavily infest the logs and penetrate to greater depths so that the commercial value of the timber becomes greatly reduced. Though the species has been reported to attack and kill healthy standing trees on the mainland of India (Stebbing, 1914), no such instance has so far been observed in these islands. However, in some instances, the species has been found to infest unhealthy standing trees of *Salmalia malabarica*, *Canarium euphyllum* and *Tetrameles nudiflora* and cause their death.

5. **Ceresium andamanicum** Gahan

(Pate-IV, figure-D)

Ceresium andamanicum Gahan, 1906. *Fauna Brit. India* (Col.) 1 : 161-162. *Type locality* : Andaman Islands.

Distribution :— ANDAMANS : *North Andaman* : Aerial Bay, Diglipur, Kshudirampur, Lakshmipur, Mayabundar and Tugapur ;

Middle Andaman : Rangat, Bakultala, Yeretta jetty and Kadamtala ; *South Andaman* : Port Blair, Wandur, Kaddalgunj, Wright Myo, Baratang Island, Niel Island, Havelock Island and Peel Island and *Little Andaman* : Hut Bay. Quiary and Penta (all present records).

ELSEWHERE : None.

The genus *Ceresium* is represented by threee species, namely, *andamanicum*, *flavipes* and *geniculatum*, in the islands of Andaman. The first species is an endemic one of rare occurence in these islands, while the second is common with a wide distrubution in the Oriental and Malagasy Regions. The third species, *C. geniculatum*, is also a common spcies with an extended distribution onto the Indian mainland including some neighbouring countries. However, all the species are almost identical in their major biological features, except for the striking characteristic features of the pupal chambers and duration of different stages of development. *C. andamanicum* is dealt with in detail, while for the others only the salient features are given.

The species, *Ceresium andamanicum*, is recorded here from these islands for the first time since its discovery in 1906. The species has been collected on several occasions from the timber extraction coupes and logging centres in the forest area. The freshly felled logs and dead or dying trees of *Planchonia andamanica*, *Artocarpus lakoocha* and *Ficus carica* are found to be highly susceptible to attack by this borer.

After successful copulation, the female starts ovipositing in groups of two to four ova in the cracks and crevices on the bark or in suitable sites under the bark. Incubation requires a period from 6 to 9 days and the newly hatched larvae penetrate down to the bast and begin to excavate their tiny galleries, radiating in all directions from the site of oviposition, where the first moult takes place after about a fortnight. During their progressive development, the larvae excavate very irregular and closely crowded galleries, packed tightly with a fine powdery frass, in between the bark and subcortical tissues. After passing through six instars within a span of about four months, the mature larvae mine at various depths from 0.67 to 2.31 cm inside the wood. All the speciesof the genus show characteristic pupal chamber formation. These chambers are nothing but the extended ends of the tunnels made by the pre-pupating larvae. In *C. andamanicum*, the pupal chamber is distinctly narrow and provided with two narrow tunnels, exacavated more or less at right angles to the original axis

of the chamber, one is at its proximal end and the other at the distal end, thus giving an I-shaped appearance. The opening of the pupal chamber is plugged tightly with wood-fibres. The pupal chamber ranges from 2.19 to 3.47 cm in length and from 0.32 to 0.60 cm in width. The pupal period varies from 10 to 21 days. The adult after a dormancy of about two weeks emerges through the entrance-hole by removing the wood-fibres. Complete development usually requires 4-5 months, although a small percentage of some progeny may take six months or even more.

Adult emergence occurs throughout the year, except for the dry months of January to March, with the maximum frequency during the period from the third week of May to the end of July. Sexual and feeding activities usually occur during the evening to mid-night and may be continued throughout the night. Food and feeding habits of the beetles have been tested in the laboratory. The laboratory-bred adults were provided with different components of plants including leaves, bark, twigs, flowers, etc., of a number of hosts, which they hardly accepted. The adult populations mostly are inactive during day remaining in cool and shady places and are strongly attracted to artificial light after sunset. The average adult longevity has been estimated at 26 days under laboratory conditions.

The species is a shallow sap-wood borer of felled logs causing rapid destruction of the entire cortex and subcortex. A heavy infestation, in the unhealthy standing trees, may enhance the chance of tree-mortality.

6. **Ceresium flavipes** (Fabricius)

(Plate—IV, figures—B & C)

Saperda flavipes Fabricius, 1792. *Ent. Syst.*, **1**(2) : 329. *Type locality* : Europe and Algeria.

Stenochorus simplex Gyllenhal, *Schönh. Syn, Ins. App.*, **2** : 178.

Arhopalus ambriguus Newman, 1842, *Entomologist*, **1** : 246.

Ceresium flavipes : Lacordaire, 1869. *Gen. Co.*, **8** : 354 ; Beeson and and Bhatia, 1939. *Indian Forest Rec. (N. S.) Ent.*, **5**(1) : 41 ; Duffy, 1968. *Imm. Stages Orient. Timb. Beetles*, p. 144 ; Gressitt and Rondon, 1970. *Pacif. Insects Monogr*, **24** : 96 ; Tiwari, *et. al.*, 1980. *Rec Zool. Surv. India*, **77** : 359.

Ceresium simplex, Gahan, 1906. *Fauna Brit. India* (Col.), **1** : 162.

Distribution :— ANDAMANS : *North Andaman* : Aerial Bay and Diglipur ; *Middle Andaman* ; Rangat, Bakultala and Kadamtala ; *South Andaman* : Port Blair, Panighat, Wandur, Chidyatapu, Kaddalgunj, Baratang Island, Niel Island, Havelock Island and Peel Island, and *Little Andaman* : Hut Bay and Ramkrishnapur (all present records). ELSEWHERE : Indian mainland, Sri Lanka, Burma, Malay Archipelago, Sumatra, Java, Laos, Philippines, New Guinea, Madagascar, Mauritius, Mexico, Europe and Algeria.

This cerambycine-borer has been recorded only from *Casuarina equisetifolia* in the mainland of India (Stebbing, 1914). Recently, Tiwari, *et. al.* (1980) have furnished a brief account of the gallery pattern of this borer infesting the wounds and scars of the living mangrove plant, *Rhizophora apiculata* in the South Andaman and Car Nicobar. However, the borer has frequently been found to infest the felled logs and dead or dying trees of *Casuarina equisetifolia*, as well as, the wounds and scars of unhealthy trees of *Rhizophora apiculata* in several islands of the Andamans.

The general biological features of this species are remarkably identical to those of *C. andamanicum*. In brief, the biology of this species stands as follows : The eggs are deposited in batches of 3 to 6 and incubation requires 5 to 11 days. The major part of the larval life is spent in irregular galleries mostly confined to the subcortical area of the infested host-material. The mature larvae penetrate further down upto 4.6 cm inside the wood wherein pupation takes place. The pupal chamber of this species is largest of all the species of the genus measuring 2.90 to 5.10 cm in length and 0.50 to 0.80 cm in width, in accordance with its largest body-size of all species of this genus, found in these islands. Somewhat 'T'-shaped appearance of the pupal chamber is the distinctive biological feature of *C. flavipes* (Plate—IV, fig. C). A narrow tunnel is excavated at right angles to the main axis of the pupal chamber at its proximal end. The larvae take 3 to 5 months to develop, which in turn, take 14 to 19 days to develop into adult. The dormant adults normally spend an average period of two weeks in the pupal chamber before they emerge as mature beetles through the entrance-hole of the pupating larvae. On the mainland of India, the species is known to have an annual life-cycle with the emergence period during the month of June (Beeson and Bhatia, 1939). However, in the islands of Andaman, it takes 5 to 7 months to complete its life-cycle.

The adults are very active in the areas with suitable host-material especially in the timber extraction centres inside the forest. Adult

emergence occurs almost throughout the year except for the months of January and April, with a maximum frequency during the monsoon months of May to July. The adult beetles feed on different tender parts of a number of plants including the larval hosts and are strongly attracted to artificial light after sunset. The average adult longevity is about three weeks in captivity.

The species is a shallow borer and, hence, appears to be only slightly injurious to the timber. Occasionally, the species has been observed to infest living trees of *Casuarina equisetifolia*, especially through the wounds and scars of the older trees. The destructive propensity of the borer in the living plants in the Andamans is not assessed, though Stebbing (1914) has already reported this species as committing serious damage to the *Casuarina* plantations on the mainlaind of India.

7. **Ceresium geniculatum** White

(Plate—III, fig. D & Plate—IV, fig. A)

Ceresium geniculatum White, 1855. *Cat. Col. Brit. Mus.*, **8** : 245. *Type-locality* : East Indies ; Gahan, 1906. *Fauna Brit. India* (Col), **1** : 158 ; Gressitt and Rondon. 1970. *Pacif. Insects Monogr.*, **24** : 99, fig. 19, a.

Ceresium rufipes Pascoe, 1869. *Trans. ent. Soc. Lond.*, 3(3) : 537.

Distribution :— ANDAMANS : *North Andaman :* Diglipur and Mayabundar ; *Middle Andaman :* Bakultala and Kadamtala and *South Andaman* : Port Blair, Wandur, Kaddalgunj, Baratang Island, Niel Island, Havelock Island and Peel Island (all present records).

ELSE-WHERE : Indian mainland, Burma, Thailand, Indonesia, Laos, Flores and Timor.

In the islands of Andaman, this species is fairly common and usually infests the larger logs and trees exceeding 7.5 cm in diameter. There is very little published information on the biology of the species from India including the Andamans. However, the present account is mainly based on the study and collection of the species infesting the felled logs and dead or dying trees of *Terminalia manii*, *Artocarpus lakoocha* and *Lagerstroemia hypoleuca* occurring in the Andamans.

The biology and habits of *C. geniculatum* are basically similar to

those of the other species of the genus *Ceresium* except for a few points noted below. The larval instars are each of about two weeks duration. Development is usually accomplished inside irregular galleries which are mostly confined to between the inner-bark and outer wood-surface. The mature larvae mine at a depth of 0.98 to 3.38 cm inside the wood, where they construct their pupal chambers along the course of the wood-fibres. The pupal chamber is comparatively smaller but similar in shape and orientation to that of *C. flavipes*. It is 2.5 to 4.3 cm in length and 0.46 to 0.70 cm in width. But in *C. geniculatum*, the 'branch-tunnel' is directed either upwards or downwards so that the pupal chamber is 'L'-shaped in appearance (Plate-III, fig. D). The opening of the pupal chamber is plugged tightly with wood fibres as usual. The duration of the pupal life usually varies from 15 to 27 days with an average of 17 days. The dormant adults spend about two weeks in the pupal chamber before emerging as mature beetles by removing the plug, through the entrance-hole of the pre-pupating larvae. Complete development usually requires 5 to 6 months, although under certain circumstances, development may require 7 months or longer as observed in the laboratory and in some field sites of South Andaman.

The emerging adult populations are found throughout the year, except for the dry months of January and February, with a maximum emergence during the early monsoon months of June and July. The newly emerged adult beetles mate and oviposit after 4 to 5 days. The insect is nocturnal and strongly attracted to artificial light after sunset. The adult beetles thrive well on tender bark and twigs of the larval host-plants. The estimated average adult longevity is about 25 days under laboratory conditions.

In the islands of Andaman, though the species is predominantly a shallow sap-wood borer inflicting damage to dead and dying wood, it sometimes attacks unhealthy standing trees. However, because the damage is confined to the outer layers (upto 6 cm) of the wood, this species appears to be of less importance than the other borers.

8. **Xylotrechus buqueti** (Laporte & Gory)

(Plate—V, figure—A)

Clytus buqueti Laporte & Gory, 1841. *Mon. Gen. Clytus*, 86p., Pl. 16, fig. 99. *Type-locality* : Java.

Xylotrechus buqueti : Chevrolat, 1863. *Mem. Soc. Sci. Lie'ge*, **18** ; 323 (71) ; Gahan, 1906. *Fauna Brit. India* (Col.), **1** : 243 ; Beeson &

Bhatia, 1939. *Indian Forest Rec.* (*N. S.*) *Ent.* **5**(1) : 189-190 (biology) ; Duffy, 1968. *Imm. Stages Orient Timb Beetles,* 207p. (larva); Gressitt & Rondon, 1970. *Pacif. Insects Monogr.*, **24** : 200, fig. 33, *d*.

Distribution :—ANDAMANS : *North Andaman :* Aerial Bay, Diglipur, Lakshmipur, Kshudirampur and Mayabundar ; *Middle Andaman* : Kadamtala ; *South Andaman* : Kaddalgunj, Wimberlygunj, Chidyatapu, Wandur, Baratang Island, Niel Island, Havelock Island and Peel Island and *Litile Andaman* : Ramkrishnapur and Penta (all present records)

ELSEWHERE : Indian mainland, Burma, Thailand, Java and Laos.

The species is a very common borer usually found infesting the superficial layers of old felled logs and dead trees. To date, it has been recorded from about 19 host-plants from different areas of south-east Asia including India. The species is recorded here for the first time from the logs of *Dipterocarpus* sp. and *Lagerstroemia* sp., and from three unidentified woody climbers belonging to the family Leguminoceae.

The females of *Xylotrechus buqueti* oviposit groups of 2 to 6 ova in the outer bark. Incubation requires a period from 6 to 10 days. The newly hatched larvae start feeding on the subcortical tissues and excavate their galleries which radiate horizontally from the site of oviposition. Older larvae gradually excavate very irregular and extensive galleries, packed tightly with a fine floury frass, in the subcortical zone engraving slightly on the wood-surface. In heavy infestations, the larval galleries have been found to cross each other so irregularly that the individual galleries cannot be discerned. The larval instars are each of about two weeks duration both in the field and in the laboratory. Usually pupation occurs at a depth varying from 1.17 to 2.63 cm inside the sap-wood (Plate—V, fig. A). The pupal chamber is not constant in shape and orientation, but hardly exceeds 1.4 cm in diameter. The pupal period is of from 14 to 22 days duration with an average of about two weeks. The adults after an average period of 12 days in dormancy, emerge by excavating short exit-holes through the wood and bark. Complete development usually requires 4 to 5 months, though an extended life-cycle is not uncommon.

The emergence of adults occurs almost throughout the year, with a maximum abundance during the monsoon months of July and August and minimum during the dry months of January and April. The first mating usually takes place on the day of emergence and oviposition follows after an interval of 4-5 days, as has been observed under labora-

tory conditions. The beetles are mostly diurnal in habit. Feeding, mating and oviposition occur during day time, all of which attain their maximum intensity during the period from late afternoon to dusk. However, the beetles hardly take any food provided in the laboratory. The estimated average adult longevity is about 17 days in captivity.

Since this species is a shallow borer and never infests living trees, it causes only minor damage in the islands of Andaman.

9. **Halme caerulescens** Gahan

(Plate—V, figures—B-D)

Halme caerulescens Gahan, 1906. *Fauna Brit. India* (Col.), **1** : 312.
Type-locality : Andaman islands.

Distribution :— ANDAMANS : *North Anadaman :* Aerial Bay and Kshudirampur ; *Middle Andaman :* Kadamtala and *South Andaman* : Port Mout, Chidyatapu, Wandur, Kaddalgunj, Wimberlygunj, Wright Myo, Lohabari, Baratang Island, Havelock Island and Peel Island (all present records).

ELSEWHERE : None.

This small cerambycine borer is endemic to these islands and is infrequently found in the timber exraction and logging centres, timber depots and other forest areas. No published information on the biology of this species was available in the literature until the present observations were made. The species has been collected along with all the developmental stages from dead logs and branches of *Terminalia manii* in several field sites and once from some unknown trees of less economic importance at Peel Island, South Andaman.

Like most species belonging to the subfamily Cerambycinae from these islands, the eggs are deposited in groups of 2 to 6 in the cracks and crevices of the bark or even under the bark. After an incubation period of 5-9 days, the newly hatched larvae penetrate down to the bast and start feeding subcortically. Larval galleries are irregular, but there is a tendency for them to run parallel to the axis of the log or tree and are packed tightly with a fine powdery frass (Plate—V, fig. B). Each of the six larval instars lasts from 9 to 14 days. Pupation takes place at a depth of 1.67—2.81 cm inside the wood. Interestingly enough,

the pupal chamber is vertical to the wood-fibres (Plate—V, fig. C) unlike that of the other cerambycid-borers of these islands. Before pupating, the larva returns back to the bark and widens and cleans the entrance-hole for future emergence of the adult. For the time being, the opening of the pupal chamber is closed tightly by a plug of wood-fibres. The pupal period is of from 9 to 21 days duration with an average of 14 days. After about 12 days in dormancy, the adults emerge through the entrance-hole of the larvae by cutting an ovoid exit-hole in the bark (Plate—V, fig. D). The complete development from egg to adult takes about 3-4 months. However, on one occasion at Kaddalgunj, the progeny infesting a small branch of *Terminalia manii* required five and a half months to complete development.

The adults are active throughout the year with maximum abundance during Mid-May to Late-August, in the timber extraction coupes and logging centres, as well as, in the forest areas. First matings usually occur within -3 hours after the emergence and oviposition follows after an interval of 4-5 days as confirmed in the field and laboratory studies. The species is diurnal in habit and the adults are sexually active during day time which may extend upto the early evening hours. Adult food habits are not fully known. The estimated average span of the active imaginal life is 11.3 days under laboratory conditions.

The species is a shallow borer of the little economic consequence and the damage by the larvae is restricted to the outer layers of the wood. The species has never been found attacking living trees or causing significant damage to the felled trees or logs in these islands.

SUBFAMILY (iii) : LAMIINAE

Amongst all the cerambycid-beetles studied in the islands of Andaman, the lamiine-species are very common and more in numbers. Some species differ considerably in their habits and habitats within the limits of generalized biological features of the lamiine-beetles as a whole. Likewise, there are many a biological criteria common to a number of species. In order to avoid repetition, some of these habits are mentioned here.

Mention may be made of a dozen of species, which show some remarkable uniformity in their habit of ovipositing in the outer layer of the bark and pupating either in the bark or in the sap-wood or in both. These species are *Clyzomedus annularis* Pascoe, *Coptops rufa* Thomson, *Ropica honesta* m. *rufescens* Pic, *Pterolophia* (*s. str.*)

andamanica Breuning, *P.* (*s. str.*) *pallidifrons* Breuning, *P.* (*s. str.*) *sterculiae* Breuning, *Desisa* (*Cyclindrostyrax*) *marmorata* Breuning, *Mispila* (*s. str.*) *venosa* m, *augularis* Pascoe, *Xenolea tomentosa* (Pascoe). *Exocentrus* (*Camptomyme*) *alboscutellaris* Breuning, *Glenea* (*Stiroglenea*) *andamanica* Breuning and *Serixia* (*s. str.*) *andamanica* Gardner. The larvae of all these species pass through six instars, except in the species, *Exocentrus* (*Camptomyme*) *alboscutellaris* and *Serixia* (*s. str.*) *andamanica*, wherein the larvae mature through five instars. The estimated sex-ratio of majority of the species is 1 : 1. However, in the cases of *Pterolophia* (*s. str.*) *pallidifrons* and *P.* (*s. str.*) *sterculiae* the percentage of the females is slightly higher.

On the other hand, about half a dozen of species, namely, *Pharsalia* (*Cycos*) *subgemmata* (Thomson), *Epepeotes* sp. *Acalolepta andamanica* (Breuning), *A. admixta* (Gahan), *A. rusticator* (Fabricius) and *Olenecamptus bilobus* (Fabricius), oviposit in the middle layer of the bark of the different host-plants. The larvae with seven successive instars and the adults with equal number of males and females are the common criteria of this group of species, except in two. *Olenecamptus bilobus*, a very common species in the area, has the larvae with six instars and the females with double the number of the males. A sex-ratio of 1.4 ♀ : 1 ♂ is also observed in the species, *Acalolepta rusticator*. The majority of the species pupate in the sap-wood except a single species, *Pharsalia* (*Cycos*) *subgemmata*, which pupates in and around the heart-wood.

The heart-wood borer, *Batocera rufomaculata* var. *andamana* Thomson, oviposits much deeper in the phelloderm layer of the bark and the larvae with seven instars penetrate into the heart-wood for pupation. The adult populations are represented by an equal number of males and females.

1. **Clyzomedus annularis** Pascoe

(Plate—VI, figure—A)

Clyzomedus annularis Pascoe, 1866. *Proc. zool, Soc. Lond.*, p, 234, *Type-locality* : Malayasia ; Penang ; Breuning, 1939. *Nov. Ent.*, 3me suppl., **54** ; 425 ; Rondon & Breuning, 1970. *Pacif. Insects Monogr.*, 24 ; 327, fig., 3, e.

Distribution :— ANDAMANS : *Middle Andaman* : Bakultala and Kadamtala ; *South Andaman* : Chidyatapu, New Wandur, Wimberlygunj,

Kaddalgunj, Kadakachan, Baratang Island, Niel Island, and Peel Island and *Little Andaman* : Ramkrishnapur (all present records).

ELSEWHERE : Indonesia, Malaysia and Laos.

This is a very common species in the Islands of Andaman and has been observed to breed in dead or dying wood. To date, no published biological information is available on this species. During the course of the present study all the developmental stages have been collected from five host-plants, of which *Canarium euphyllum*, *Mangifera indica* and *Semecarpus kurzii* are the most important ones from an economic standpoint.

The female deposits her eggs singly inside egg-pits, made in the outer bark with the aid of her mandibles. However, in the smaller logs with heavy infestations, about 4% of the egg-pits are found to contain two eggs. The opening of the egg-pits are sealed with a resinous substance immediately after oviposition. After a brief incubation period of between 5 and 6 days, the larvae hatch and penetrate down to the phelloderm layer of the bark, thereby resulting in the formation of the larval galleries. After a brief period of feeding on the phelloderm tissue, the larva penetrates into the subcortical tissue, where the entire larval life is spent. As they grow older, the larvae gradually excavate very irregular and extensive galleries in the subcortical zone, engraving in between the inner surface of the bark and the outer surface of the wood. However, the gellaries are mostly confined to the bark, rather than in the sap-wood. As usual, the larval galleries are packed tightly with a fibrous frass. The larval instars each lasts for an average of 10 days. The full grown, sixth-instar larvae excavate shallow ovoid pits (0.3 to 0.5 cm deep) on the wood-surface, just below the bark, which ultimately become the pupal chambers (Plate—VI, fig. A). The overlying bark serves as the roof, while the wood-surface is the floor of the pupal chamber. The surrounding walls of these chambers are constructed with the help of fibres of bark and wood in such a pattern that the whole structure attains the appearance of a miniature "Bird's nest". The pupation period varies from 12 to 19 days with an average of 14 days. Before emergence, the adults remain dormant for about 10 days within the pupal chamber. They emerge by chewing their way out through the distal end of the pupal chamber, leading to more or less circular exit-holes of 0.80 to 0.98 cm in diameter on the bark surface. Complete development usually requires three months, although a small percentage requires four months or even longer.

Adult emergence occurs throughout the year with a maximum frequency during the early monsoon months from June to August and

is at a minimum during the dry month of April. In almost all the instances, no individual has been found to take part in courtship and mating before consuming sufficient amount of food unlike the prionine and cerambycine beetles. Oviposition usually follows after an interval of 4 to 5 days from the first mating. The species is apparently nocturnal, since feeding, mating and oviposition occur during the period from dusk to the late evening hours and may continue upto mid-night. The insect is attracted to artificial light during the night, but during day light they have been observed to take shelter in shady places. The adults obtain their nourishment by gnawing the bark of a number of plants including the larval hosts. The estimated average adult longevity is about 53.8 days under laboratory conditions.

The larvae complete their development under the bark causing no significant damage to the timber. No instances of infestation in living trees has so far been recorded.

2. **Coptops rufa** Thomson

(Plate—VI, fig. B)

Coptops rufa Thomson, 1878. *Revue Zool.*, (3) **6** : 60. *Type-locality* ; Andaman Islands.

Distribution :— ANDAMANS : *North Andaman* : Aerial Bay and Diglipur ; *Middle Andaman* : Bakultala, Yeretta Jetty and Kadamtala ; *South Andaman* : Port Blair, Terelybad, Rangachan, Bidnabad, Wandur, Chidyatapu, Wimberlygunj, Kaddalgunj, Kadakachan, Wright Myo, Panighat, Baratang Island, Niel Island, Havelock Island and Peel Island and *Little Andaman* : Quiary, Ramkrishnapur, Vivekanandanagar and Penta (all present records).

ELSEWHERE : None.

The species is a very common borer of felled logs or dead trees in these islands. No biological information is available on this species. In the present study, the borer was collected on a number of occasions in different islands from only four host-plants (*Vide*, table—1) among which *Canarium euphyllum* and *Pterocymbium tinctorium* are most important from an economic point of view.

The general biology of this species closely resembles that of *Clyzomedus annularis* already referred to earlier. The eggs are laid singly

inside the egg-pits, excavated by the females in the bark of dead wood and the opening of the egg-pit is subsequently sealed with a resinous substance as observed in many instances. After an incubation period of 5-6 days, the resultant larvae bore down to the phelloderm layer of the bark. Here the first moult takes place within 5-6 days from hatching. The newly moulted larvae penetrate further down to the subcortical zone under the bark and with progressive age they excavate irregular galleries engraving both the inner surface of the bark, as well as, the outer surface of the wood, although the major portion of the larval galleries is in the inner bark. The gallery pattern of *C. rufa* and *Clyzomedus annularis* are almost identical except for the deeper galleries of the former species. The larval instars each has an average duration of 11 days. The ovoid pit made by the sixth-instar larva at a depth of 1.2 to 2.0 cm in the wood is usually used for pupation (Plate—VI, fig. B). The pupal chamber ranges from 3.0 to 3.6 cm in length and from 2.0 to 2.3 cm in width. Pupal duration varies from 12 to 18 days with an average of 14 days. The adults remain dormant for an average of 10 days and then emerge through the distal end of the pupal chamber leading to more or less circular exit-holes of 1.21 to 1.36 cm in diameter. The species usually requires 3 to 4 months to develop from the egg to adult.

Adult emergence occurs almost throughout the year with its maximum abundance during the monsoon months of July and August. After a lapse of 6 to 18 hours of taking food the newly emerged adults mate and oviposition follows within 4-5 days. The beetles seem to be diurnal, since the feeding, mating and oviposition activities are mostly confined to day time with their peak in the afternoon. On one occasion, some females were observed ovipositing on a recently felled tree of *Samanea saman* at 7.15 PM during August, 1980 in the South Andaman. The adults usually obtain nourishment by gnawing the bark and twigs of a number of plants, such as *Canarium euphyllum*, *Ficus* spp., *Samanea saman*, *Salmalia insignis*, *Pterocymbium tinctorium*, *Tetrameles nudiflora*, etc., of which the first one is the preferred host. The male and female sex-ratio has been estimated at 1 ♂ : 1.35 ♀ in the field and insectaries. The estimated average adult longevity is 52 days under laboratory conditions.

Larvae complete their development entirely under the bark and consequently cause only slight damage to the timber. It never infests living healthy trees.

3. Ropica honesta m. rufescens Pic

(Pate—VI, figure—C)

Ropica posticalis var. *rufescens* Pic, 1926. *Me'lang. exot.-ent*, **46** : 5. *Type-locality* : Tonkin.

Ropica rufescens : Beeson and Bhatia, 1939. *Indian Forest Rec.* (*N. S.*) *Ent.*, **5** (1) : 171 (biology) ; Duffy, 1968. *Imm. Stages Orient. Timb. Beetles*, 328 p.

Ropica honesta Pascoe m. *rufescens* : Breuning, 1964. *Ent. Abh. Mus. Tierk. Dresden*, **30** : 375.

Distribution :— ANDAMANS : *Middle Andaman* : Kadamtala ; *South Andaman* : Port Blair, Panighat, Wimberlygunj, Kadakachan, Wright Mayo, Ferrargunj, Port Mout, Wandur, Shippighat, Terelybad, Chidyatapu, Baratang Island, Niel Island, Havelock Island and Peel Island and *Little Andaman* : Hut Bay (all present records).

ELSEWHERE : Indian mainland, Bhutan, Burma, Indonesia, Sumatra, Java, Borneo, Lombok, Vietnam, Laos, Moluccus, Celebes, Philippines, China and New Guinea.

Ropica honesta m. *rufescens*, a small lamiine, measuring 0.6 to 0.8 cm in length, is widely distributed in the south-east Asia with an extended distribution upto Papuan Region. Beeson and Bhatia (1939) recorded the species from 14 host-plants of which only three occur in the Andamans. In the present study, it has been collected on several occasions from the dead logs, branches and trees of a single host-plant, namely, *Samanea saman*. This is the first record of *S. saman* as a host of *R. honesta* m. *rufescens* on the Andaman islands.

Ova are laid singly inside egg-pits in the outer layer of the bark, the openings of which are immediately sealed with a resionous substance after oviposition. After an incubation period of 4-6 days the larvae hatch and start feeding on the cortical tissues where the first moult takes place within 5 days from hatching. The second instar larvae penetrate further into the subcortical zone where further moults take place at regular intervals of a week or so. The pupal chamber is extremely small in size, measuring 0.57 — 0.83 cm in length and 0.31 — 0.40 cm in width. This consists of the end of the larval gallery excavated solely within the bark (Plate—VI, Figure—C). The pupal period lasts for 7 to 16 days with an average of 9 days. After passing an average period of 7 days as a dormant adult, the mature beetle emerges by chewing a passage through the bark, leading to a more or less circular exit-hole

of 0.29 to 0.34 cm in diameter. Complete development usually requires 2-3 months depending upon the host and other conditions. However, a small percentage of the progeny may take more than 4 months.

Adults have been found active in the areas with suitable host-material almost throughout the year in these islands. Maximum abundance occurs during the months from May to July. On the mainland of India, the maximum emergence of the species also occurs during May (Beeson and Bhatia, 1939). Mating takes place after a lapse of 8-16 hours from feeding. Oviposition occurs 4 days onward from the first mating. During day, adults seem to lead inactive life, and hide in cool, shady places under plant cover. After sunset, feeding and sexual activities, as well as, oviposition are frequent. The insect is strongly attracted to artificial light. The beetles obtain nourishment by gnawing the tender bark of a number of plants including the larval hosts. The average span of active imaginal life has been calculated to be 20.7 days under laboratory conditions.

Since the larvae complete their development in and under the bark, their damage to the timbers is not at all significant. The species does not infest living trees.

4. **Pterolophia (s. str.) andamanica** Breuning

(Plate—VI, Fig. D)

Pterolophia andamanica **Breuning, 1938.** *Festschr. E. Strand*, **4** : 268. *Type-locality* : **Andaman islands ; Beeson and Bhatia, 1939.** *Indian Forest Rec.* (*N. S.*) *Ent.*, **5** (1) : 160 .biology) ; Duffy, **1968.** *Imm. Stages Orient. Timb. Beetles*, 316 p

Pterolophia (*s. str.*) *andamanica* : **Breuning, 1965.** *Ent. Arb. Mus. Frey*, **16** : 209.

Distribution :— ANDAMANS : *North Andaman* : Diglipur, Lakshmipur, Kshudirampur, Aerial Bay, Mayabandar and Tugapur ; *Middle Andaman* : Bakultala, Rangat and Kadamtala and *South Andaman* : Port Blair, Panighat, Wimberlygunj, Kaddalgunj, Kadakachan, Wright Myo, Wandur, Garacharma, Chidyatapu, Niel Island, Havelock Island and Peel Island (all present records).

ELSEWHERE : Burma.

In the islands of Andaman, the genus *Pterolophia* is represented by five species, of which three species, namely, *andamanica*, *pallidifrons* and

sterculiae, are found predominantly in this area. The first two species are restricted in these islands, while the latter also occurs in Burma. Biological information on these species is restricted to their host-plants and emergence period (Beeson and Bhatia, 1939). In the present study, sufficient biological data have been collected on these species from Andamans, which reveal the remarkable similarity in major biological features except for the tenure of developmenal period and the structure and orientation of the pupal chamber. To avoid repetition, *P. andamanica* has been dealt with in detail, while only salient features have been given for the other species.

P. andamanica is small and about 1.0 cm in length. It has been reported earlier from the Andamans and Burma infesting the dead logs of *Albizzia lucida* and *Samanea saman* (Beeson and Bhatia, 1939). In the present study, the borer has been recorded for the first time from the dead logs, branches and trees of *Albizzia lebbek*, *Duabanga sonneratioides*, *Ficus* sp. and *Mimusops littoralis*, in addition to the other hosts referred to above.

The eggs laid singly, rarely in batches of two, inside isolated egg-pits and after an incubation period of 4-5 days, the first instar larvae hatch and start feeding in the phelloderm tissue of the bark. After a short period of feeding in the phelloderm tissue, the larvae get down to the subcortical tissue where the entire larval life is spent. Each of the six larval instars lasts for an average period of a week. The larval galleries are very irregular, usually packed tightly with a fibrous frass and mainly confined to the inner bark. The sixth-instar larvae engrave slightly on the wood surface to excavate a very shallow pit in which the pupal chamber is formed. The margin of this pit is raised with the bark and wood fibres in such a pattern that the whole structure attains a tiny 'bird's nest' like appearence (Plate—VI, Fig.—D). The pupal chamber ranges between 0.50 and 0.60 cm in length, and 0.31 and 0.37 cm width. Pupal duration varies from 7 to 12 days and the adults remain dormant for about a week before they emerge through the exit-holes of 0.40 to 0.50 cm in diameter on the bark. Complete development usually requires 50 to 70 days. However, on some occasions, as observed at Panighat, Kaddalgunj and Garacharma, complete development requires more than three months, particularly in logs of very small diameter.

Adult emergence occurs almost throughout the year and is in a maximum during the months of May to August. Beeson and Bhatia (1939) have recorded the emergence during the months of January, April to June and September in the area. No adult mates before

feeding. The impregnated females usually take about 4 days to commence oviposition. Both mating and feeding are observed usually during dusk and the evening hours, though oviposition during late afternoon (1700-1730 hours) is not uncommon. The adult beetles obtain their nourishment from the bark of a number of plants particularly of the larval hosts. These beetles are strongly attracted to artificial light and shelter under the cool, shady places during the day. The average span of active imaginal life has been calculated at about 38.0 days under laboratory conditions.

The larvae complete their development under the bark, thereby causing only slight damage to the wood. This species is of little economic importance and has not been recorded from live trees.

5. **Pterolophia (s. str.) pallidifrons** Breuning

(Plate—VII, Fig.—A)

Pterolophia pallidifrons Breuning. 1938, *Festschr. E. Strand.* **4** : **273.** *Type-locality* : Andaman islands ; Beeson and Bhatia, 1939. *Indian Forest Rec. (N. S.) Ent* **5** (1) : **164** (biology) ; Duffy, 1968. *Imm. Stages Orient. Timb. Beetles,* **311** p.

Pterolophia (s. str.) pallidifrons : Breuning, 1965. *Ent. Arb. Mus. Frey,* **16** : 207.

Distribution :— ANDAMANS : *North Andaman* : Diglipur, Aerial Bay and Mayabandar ; *Middle Andaman* : Bakultala and Kadamtala and *South Andaman* : Port Blair, Panighat, Chidyatapu, Wandur, Garacharma, Wimberlygunj, Kadakachan, Niel Island and Peel Island (all present records).

ELSEWHERE : None.

Pterolophia (s. str.) pallidifrons, an endemic species to the islands of Andaman, is the largest member of the genus measuring about 1.5 cm in length. It is known to infest the dead wood of *Mimusops littoralis* and *Sterculia alata* in these islands (Beeson and Bhatia, 1939). However, specimens have been collected from dead logs, branches and trees of the above mentioned hosts on three occasions only. In addition, it has been collected on several occasions from the newly recorded host-plant, *Samanea saman* from different localities in the Andamans.

Eggs are laid singly in the outer bark of the host-material inside egg-pits. However, a few egg-pits-(about 1.5%) have been found to contain

two eggs. After an incubation period of 4-5 days, the newly hatched larvae bore down to the phelloderm layer of the bark and excavate extensive galleries therein. The larval development including the duration of the instars and its associated phenomenon are very similar to those of *P. andamanica* as mentioned earlier. The pupal chamber is an ovoid and shallow pit (0.4—0.6 cm in depth) formed on the surface of wood, without any pronounced wall giving the appearance of a 'bird's nest' like that of *P. andamanica* (Plate—VII, Fig. A). It varies from 1.30 to 1.34 cm in length and from 0.72 to 0.97 cm in width. The pupal period lasts 8-13 (average 10 days) days. The adults remain dormant for about a week before emerging as mature beetles through exit-holes of 0.70-0.84 cm in diameter. Complete development usually requires an average period of two months, with an extended period of about three months in some rare instances.

Beeson and Bhatia (1939) have recorded the adult emergence during the months of March to May and in July in these islands. In this study it was found that it extended throughout the year reaching a maximum during the period from May to August. The ratio of females to males of the emerging populations is on an average of 1.35 ♀ : 1 ♂ in the field and insectaries. In certain individual field sites the results ranging from 2.0 ♀ ; 1.0 ♂ to 2.0 ♂ : 1.0 ♀ were obtained. The average adult longevity is 33 days under laboratory conditions.

The larvae seem to be of minor economic importance.

6. Pterolophia (s. str.) sterculiae Breuning

(Plate—VII, Fig. B and C).

Pterolophia sterculiae Breuning, 1938. *Festschr. E. Strand.*, **4** : 273. *Type-locality* : Andaman islands ; Beeson & Bhatia, 1939. *Indian Forest Rec.* (N. S.) Ent., **5** (1) : 164 (biology).

Pterolophia (s. str.) sterculiae : Breuning, 1965. *Ent. Arb. Mus. Frey*, **16** : 221.

Distribution :— ANDAMANS : *North Andaman* : Diglipur, Aerial Bay and Mayabandar ; *Middle Andaman* : Kadamtala and *South Andaman* : Port Blair, Panighat, Kadakachan, Chidyatapu, Baratang Island and Niel Island (all present records).

ELSEWHERE : None.

This beetle, a medium sized species measuring about 1.1 cm in length, is an endemic species to the Andamans. It is less frequently found than the other two species of the genus. The borer is already recorded from the felled logs and dead trees of *Sterculia alata* in the North Andaman (Beeson and Bhatia, 1939). However, the species also breeds in the felled logs, dead branches and trees of *Aegle marmelos* and *Ficus religiosa,* as noted in the present study.

The biology of this species, in general, is very similar to that of the other species of the genus already referred to above. Each of the six larval instars has an average duration of five days in contrast to seven days for the other two species of the genus. The full grown larvae engrave slightly on the wood surface to form an ovoid pit which is used as the pupal chamber. The pupal chamber is very similar to that of *P. andamanica* except that it is a little larger measuring from 0.65 to 0.79 cm in length and from 0.41 to 0.50 cm in width (Plate-VII, Fig. C). The duration of the pupal life varies from 7 to 11 days with an average of 8 days. The adults remain dormant for about 6 days, and then emerge by excavating exit-tunnels through the bark leading to more or less circular exit-holes of 0.28 to 0.46 cm in diameter. Complete development usually requires a period of 46 to 69 days with an average of 53 days.

The emergence of adults takes place almost throughout the year reaching a maximum during the period from mid-April to the early monoon months of June and July. Beeson and Bhatia (1939) recorded the emergence in April in these islands. However, this species differs from *P.* (*s. str.*) *andamanica* and *P.* (*s. str.*) *pallidifrons* as it is nocturnal, with a peak of mating and feeding activities during early night hours. The beetle is attracted to artificial light after sunset. Adults also seem to be very active after sunset unlike the other relatives of the genus, and inactive during day time. The sex-ratio has been observed to be 1.15 ♀ : 1 ♂ in both the natural and laboratory bred populations. However, a few field sites yield ratios in favour of the males. The estimated average adult longevity is about 40 days under laboratory conditions.

The species can hardly be rccognised as economically important, since the feeding activities of the larvae are confined to the bark of the host only.

7. **Desisa (Cylindrostyrax) marmorata** Breuning
(Plate—VII, Figure D)

Desisa marmorata Breuning, 1938. *Festschr. E. Strand,* **4** : 374. *Type-locality* : Andaman Islands.

Desisa (Cylindrostyrax) marmorata : Breuning, 1963. *Ent. Arb. Mus. Frey,* **14**(1) ; 183.

Distribution :— ANDAMANS : *South Andaman* : Port Blair, Wandur and Peel Island (all present records).

ELSEWHERE : None.

Desisa (Cylindrostyrax) marmorata is recorded here for the first time from these islands, since its discovery in 1938. The present collection data indicate its infrequent occurrence in these islands, where it infests the felled logs and dead or dying trees of all dimensions of *Pterocarpus dalbergioides, Cassia fistula* and *Tectona grandis.*

Eggs are deposited inside the egg-pits in the outer bark (Plate—VII, Fig. D). After an incubation period of 5-7 days, the newly hatched larvae bore into the phelloderm layer of the bark and within 5 days or so, they get down to the subcortical tissue where they complete their development. With progressive age, the larvae excavate extensive, irregular galleries in the subcortical zone, engraving on the inner surface of the bark and outer surface of the sap-wood. The larval galleries are packed tightly with a fine granular frass. Each of the larval instars has an average duration of 8 days. Pupation usually takes place under the bark, although a certain percentage of larvae pupates at a depth of 0.7 to 2.9 cm inside the sap-wood. The duration of the pupal stage usually ranges from 10 to 16 days with an average of 12 days. After passing about a week or so as a dormant adult, the mature beetle emerges by chewing its passage through the distal end of the pupal chamber leading to a more or less circular exit-hole of 0.21 to 0.33 cm in diameter. Complete development usually requires 2 to 3 months. However, under certain circumstances, particularly among the populations infesting smaller branches, the developmental period has been found to be extended upto three and a half or even four months.

The adults are active during dusk in the timber extraction and logging centres, timber depots and different forest areas around suitable host-plants throughout the year. Maximum abundance occurs during

the monsoon months of July to September. They are crepuscular remaining active during the period from dusk to evening which may be continued even upto midnight. However, on one occasion at Niel island, South Andaman, several females were observed actively ovipositing on a recently dead log of *Cassia fistula* during early morning (0515 hours IST) in June. The average adult longevity is 23 days under laboratory conditions.

Since the larvae feed entirely under the bark, there is very little direct damage to the wood. Living trees are not attacked by this species in the Andamans.

8. Mispila (s. str.) venosa m. augularis Pascoe

Mispila augularis Pascoe, 1878. *Ann. Mag. nat. Hist.*, (5)2 : 376). *Type-locality* : Andaman Islands.

Mispila (*s. str.*) *venosa* Pascoe m. *augularis* : Breuning, 1963. *Ent. Arb. Mus. Frey*, 14(2) : 486.

Distribution :— ANDAMANS : *South Andaman* : Baratang Island and *Little Andaman* : Ramkrishnapur, Penta, No. 11 Timber extraction centre and Vivekanandanagar (all present records).

ELSEWHERE : *Mispila* (*s. str.*) *venosa* occurs in Borneo, Java, Celebes and Tonkin.

This species, measuring about 1.4 cm in length, is infrequently found in the islands of Andaman infesting the dead logs of several host-plants. All developmental stages have been collected on four occasions in South and Little Andamans from the dead logs of *Cassia fistula*, *Ficus* sp., *Sterculia alata* and from the dead trunk of an unknown climber.

The eggs are laid singly in the outer bark, inside the egg-pits. The opening of the egg-pit is subsequently sealed with a resinous substance by the female. The incubation period usually varies from 5 to 7 days. After hatching, the larvae bore down to the phelloderm layer of the bark and construct tiny galleries, which ultimately extend to the sub-cortical zone with the progressive age of the larvae. After passing through six instars, the mature larva gradually constructs an ovoid pit which is subsequently transformed into a pupal chamber of 1.6 cm to 2.4 cm in length and 1.31 to 1.59 cm in width under the cealing of the bark. The pupa takes 8-13 days to develop. The adults remain dormant

for about a week, and then emerge by chewing their way out through the distal end of the pupal chamber, leading to more or less circular exit-holes of 0.93 to 1.01 cm in diameter. Complete development usually requires a period ranging between 2 and 3 months.

The adults are found in activity during day time in the timber extraction and logging centres and in the areas with suitable host-material. They are frequent throughout the year, with maximum abundance during the monsoon months from July to September. First mating occurs within a couple of hours after the adult feeding and oviposition follows after an interval of about 4 days. Both mating and oviposition activities occur during the cool hours of the day, particularly in the early morning or late afternoon, although in a few instances some adults are active throughout whole day in cloudy conditions. The adults usually obtain their nourishment by gnawing the bark of the larval hosts. However, sometimes they also feed on the bark and twigs of other plants. During the day they take shelter in cool, shady places. The sex ratio is 1 : 1 in the field and insectaries. The average span of the active imaginal life has been observed to be 24.4 days under laboratory conditions.

As such, the species seems to be of no economic importance.

9. **Pharsalia (Cycos) subgemmata** (Thomson)

(Plate—VII, Figure—E)

Monochamus subgemmatus Thomson, 1857. *Arch. Ent*, 1 : 294. *Type-locality* : Bangladesh : Sylhet.

Monochamus georgius White, 1858. *Proc. zool. Soc. Lond.*, **26** : 407 ; Chevrolat, 1859. *Annls. Soc. ent. Fr.*, 7(3) : 6.

Cycos subgemmatus : Lacordaire, 1869. *Gen. Col.*, **9** : 346 ; Beeson & Bhatia, 1939. *Indian Forest Rec. (N. S) Ent.*, 5(1) : 25 (biology).

Pharsalia (Cycos) subgemmatus : Breuning, 1943. *Novit. ent.*, 3 *me* suppl., **112** ; 329 ; Gressitt, 1943, *Novit. ent.*, 3 *me* suppl., 113 : 376,

Pharsalisa (Cycos) subgemmata : Rondon & Breuning, 1970 *Pacif Insects Monogr.*, **24** : 449, fig, 30, g.

Distribution ;— ANDAMANS : *North Andaman* : Diglipur, Aerial Bay and Mayabundar ; *Middle Andaman* : Bakultala, Rangat and Kadamtala and *South Andaman* : Port Blair, Panighat, Bambooflat, Mini Bay, Garacharma, Bidnabad, New Wandur, Kaddalgunj, Wright Myo, Viper Island, Baratang Island, Niel Island, Havelock Island and Peel Island (all present records).

ELSEWHERE : Indian mainland, Bangladesh, Burma, Thailand, Malacca and Laos.

This species is of frequent occurrence in the timber extraction coupes, logging centres and timber depots mainly in the forest areas of the Andaman islands. Beeson and Bhatia (1939) recorded the host-plants, emergence period, duration of life-cycle, etc., of this species on the Indian mainland. On the present study, the borer has ben collected with all its developmental stages from some six host-plants of which *Mangifera indica*, *M. andamanica*, *M. sylvatica* and *Spondias pinnata* constitute new records for this species.

The eggs are laid singly inside the egg-pits within the bark of dead or dying logs, branches or trees. Incubation requires about a week. There are seven larval instars and complete development within irregular tunnels in the subcortical tissues requires about two months. The mature larvae mine 5.5 to 8.9 cm deep inside the wood and construct their pupal chambers more or less parallel to the wood fibres to pupate therein (plate-VII, Fig. E). The pupal chamber varies from 6.6 to 8.4 cm in length and 2.2 to 2.5 cm in width. Pupal life usually lasts 10-18 days with an average of 12 days. After passing an average period of 9 days as dormant adults, they emerge by chewing their way out through the distal end of the pupal chamber leading to more or less circular exit-holes of 1.55 to 1.73 cm in diameter. Complete development usually requires a period ranging from 3 to 5 months. However, sometimes in the hosts of smaller dimension at Panighat, Bambooflat. Garacharma, New Wandur, Kaddalgunj and Viper Island, complete development has been found to require six months or even longer.

Adult emergence occurs almost throughout the year in Andamans. Maximum abundance occurs during the monsoon months of June and July and is at a minimum during the dry months of April. Feeding seems to be essential before the commencement of sexual activities and there is an interval of 2-3 days between these two events. Oviposition follows after 5 days from the first mating. The adults are predominantly nocturnal and are strongly attracted to artificial light at night, especially in the early hours, although some sexual activity is not uncommon during the early morning hours. The adults are usually inactive during the day except for hovering for a while on the green twigs of a number of plants especially in cool and moist places. The estimated average adult longevity is 61 days under laboratory conditions.

Since the larvae are shallow borers and their damage is mainly restricted to the sap-wood of the host-logs or trees, this species is hardly

recognised as an important timber pest. However, on some occasions, the larvae infest sickly standing trees of *Mangifera andamanica* and *Spondias pinnata* and may cause their death.

10. Epepeotes Sp.

(Plate—VIII, Figures—A & B)

Distribution :— ANDAMANS : *North Andaman* : Aerial Bay, Diglipur and Tugapur ; *Middle Andaman* : Bakultala and Kadamtala ; *South Andaman* : Port Blair. Bidnabad, Dhanikhari, New Wandur, Kaddalgunj, Wright Myo, Viper Island and Baratang Island and *Litile Andaman* - Hut Bay, Quiary, Vivekanandanagar and Ramkrishnapur (all present records).

ELSEWHERE : Not known.

Epepeotes sp., although widely distributed in these islands, appears to be more frequent in the southern parts of the area, particularly in Little Andaman. The exact identification of this borer has not yet been made. However, the species has been collected on many occasions from the felled logs and dead or dying trees of *Artocarpus chaplasha* and *Canarium euphyllum*, particularly in the timber extraction coupes and logging centres of the forest areas.

The general biological features of this species are very similar to those of the other lamiine shallow-borers belonging to the tribe Agniini However, in brief, the biology of the species stands as follows : The major part of the larval life is spent in tunnels confined to the sub-cortical layer of the infested logs and trees. With the progressive age, the mature larvae penetrate down to a depth of 3.71 to 7.85 cm in the sap-wood wherein the pupation takes place. The pupal chamber which varies from 5.3 to 7.1 cm in length and from 1.8 to 2.0 cm in width usually has a distinct buldging at its distal end and is placed in an inclined position not exactly parallel to the wood-fibres (Plate—VIII, Fig. B). The seven larval instars each lasts for about 10 days and the pupal stage lasts 10-17 days. The adults, after passing about a week in dormancy, emerge by chewing their way out through the distal end of the pupal chamber, leading to more or less circular exit-holes of 1.2-1.5 cm in diameter. Complete development usually requires an average period of two and a half month, although a small percentage of some cohorts take more than four months,

Adult emergence occurs almost throughout the year and reaches a maximum during the monsoon months of July to September. Moderate emergence occurs during the pre-and post-monsoon months of June, October and November with few adults emerging during the dry month of April. After one or two days of emergence, the first matings occur in the vicinity of the logs from which the adult beetles have emerged. Soon afterwards, the impregnated females disperse in search of suitable host-material for oviposition. Oviposition usually commences after an interval of 4-5 days from the first mating. The adults n.ostly feed and mate in the early morning and at dusk, but these activities may continue throughout cool and cloudy days as it has been observed in the forest areas of Little Andaman during the months of January, September and October. In the laboratory, the adult beetles usually survive slightly longer than a month and feed on the fresh bark and twigs of the larval host-plants. However, some other plants, like, *Ficus religiosa*, *Salmalia malabarica*, *Terminalia procera*, etc., are also used by the adults for feeding. The beetles are best collected at artificial light after sunset.

This species is not a serious pest of the hard-wood. However, it is destructive in heavy infestations to soft-woods where the damage may extend to depth of more than 8 cm. However, at Bidnabad, the species also infested an unhealthy tree of *Artocarpus chaplasha*. This tree was kept under constant observation for more than four months and the borer populations increased enormously and gradually destroyed the tree. Consequently, this species may sometimes be an agent causing the death of the living trees.

11. **Acalolepta andamanica** (Breuning)

(Plate—VIII, Figures—C-E)

Dihammus andamanicus Breuning, 1935. *Folia zool. hydrobiol.*, **7** : 250. *Type-locality* : Andaman islands ; Beeson & Bhatia, 1939. *Indian Forest Rec. (N. S.) Ent.*, **5**(1) : 58 ; Duffy, 1968, *Imm. Stages Orient, Timb. Beetles*, 244 p.

Distribution :— ANDAMANS : *North Anadaman* : Diglipur, Kshudirampur, Laksmipur, Aerial Bay, Mayabundar and Tugapur ; *Middle Andaman :* Bakultala, Rangat, Yeretta Jetty, Long Island. and Kadamtala ; *South Andaman* : Port Blair, School line, Garcharma, Terelybad, Shippighat, Dhanikhari, Burmanalah, Chidyatapu, Mugluton, Guptapara, Line Dera, Wandur, New Wandur, Kaddalgunj, Ferrargunj, Mathura, Wimberlygunj, Kadakachan, Wright Myo, Bambooflat,

Panighat, Mini Bay, North Bay, Viper Island. Baratang Island, Niel Island, Havelock Island and Peel Island and *Littte Andaman* : Hut Bay, Quiary, Penta, Vivekanandanagar and Ramkrishnapur (all present records).

ELSEWHERE : None.

The genus *Acalolepta* is represented by five species in the islands of Andaman among which the species *andamanica, admixta and rusticator* have been dealt with in the present endeavour. The first species is endemic and of comparatively larger size and widely distributed in these islands, whilst the smaller and rarer species, *A. admixta,* also occurs in Burma and Malaysia. The third species occurs widely in the Oriental region and infests a wide range of hosts. However, all of the species are very much identical in their major biological features, except for certain characters, such as the gallery pattern, depth of penetration, duration of both the larval and imaginal life. However, *A. andamanica* is dealt with in detail, while only distinguishing features are given for the others.

Acalolepta andamanica, the commonest lamiine on the Andamans, is recorded for the first time from a number of host-plants, namely, *Anacardium occidentale, Artocarpus chaplasha, Pterocymbium tinctorium, Salmalia insignis* and *Semecarpus kurzii.* It also infests *Canarium euphyllum* and *Terminalia procera* which were earlier reported by Beeson and Bhatia (1939).

The eggs are laid in the egg-pits in the Phellogen layer of bark of felled logs (Plate—VIII, Figs. C & D) and incubation requires from 5 to 8 days. The larval development requires about 70 days and takes place inside irregular galleries, packed with fibrous frass, being excavated in the subcortical area and then within the wood. Each of the seven larval instars lasts an average of 10 days. The full grown larvae ultimately reach a depth of about 6.50 cm where the pupal chamber, measuring 5.50 to 6.40 cm in length and 1.70 to 2.10 cm in width, is constructed along the axis of the host-log or tree (Plate—VIII, Fig. E). The pupal period lasts about two weeks and the adults remain in dormancy for about 10 days. The emerging adults chew their way out through the distal end of the pupal chamber, leading to more or less circular exit-holes of 1.1-1.45 cm in diameter. Complete development usually requires from three and a half to five months. However, in the smaller logs, this species requires six months or even longer to complete its development.

Maximum adult emergence occurs during the rainy months of June and July, while the minimum occurs during the dry months of January and February. Adults are sometimes absent during November and December. Mating and oviposition follow the similar pattern as in the other lamiines. However, this species requires a longer pre-oviposition period of 12 days in comparison to a maximum of 8 days in some other species. Adults are primarily nocturnal and are strongly attracted to artificial light. However, they may feed and mate until the next morning. In contrast, they remain inactive during the day and usually shelter in the shade of forest plantations. The average adult longevity has been estimated at 50 days under laboratory conditions.

The larvae are shallow borers of reduced economic importance. They feed in dead or dying wood and rarely attack the wounds and scars of unhealthy trees in the forest stands. Subsequent observations show that some trees gradually deteriorate and eventually die.

12. **Acalolepta admixta** (Gahan)

Haplohammus admixtus Gahan, 1895. *Ann. Mus. Genova*, **34** : 38. *Type-locality* : Burma.

Dihammus admixtus : Beeson & Bhatia, 1939, *Indian Forest Rec.* (*N. S.*) *Ent.*, **5**(1) ; 58 (biology) ; Duffy, 1968. *Imm. Stages Orient. Timb. Beetles*, 244 p.

Distribution :— ANDAMAMS : *North Andaman* : Aerial Bay and Kshudirampur ; *Middle Andaman* : Bakultala, Rangat and Kadamtala and *South Andaman* : New Wandur, Kaddalgunj, Baratang Island and Peel Island (all present records).

ELSEWHERE : Burma and Malaysia.

This small species occurs infrequently on the Andaman islands. Beeson and Bhatia (1939) recorded this borer from five host-plants of which two, *Pterocarpus dalbergioides and Pterospermum acerifolium*, are known to be infested in these islands. However, it has been collected most frequently from the dead logs and trees of a single host-plant, *Pterocarpus dalbergioides*.

Eggs are laid singly, rarely a batch of two, in the outer bark. Most of the larval life is spent in irregular galleries confined to the cortical and subcortical tissues of the infested logs or trees, whilst the mature larvae penetrate down to a depth of 3.41 cm inside the wood

wherein pupation takes place. The pupal chamber which varies from 1.7 to 2.4 cm in length and from 0.65 to 0.80 cm in width, is of similar orientation to that of the other species of the genus *Acalolepta*. The larval instars each lasts for about a week. The pupal period varies from 9 to 14 days. Dormant adults remain in the pupal chamber for about a week, before they emerge by excavating their exit-holes of 0.32 to 0.43 cm in diameter through the distal end of the pupal chamber. Complete development from the egg to adult usually requires a period ranging from two and a half to four months, or rarely even longer.

The emerging adult populations of this species are found aolmost throughout the year with a maximum abundance during the mhnsoon months of May to August. Adult emergence is minimum during the pre-monsoon months of February to April. The beetles are nocturna and are strongly attracted to artificial light. The adults usually thrive on the bark of the larval host-plants. The estimated average adult longevity is 48 days in captivity.

The species is of minor economic importance since the damage caused by the larvae is restricted to the superficial layers of the sap-wood of the dead or dying wood. However, on one occasion at New Wandur, South Andaman, the larvae infested an unhealthy standing tree of *Pterocarpus dalbergioides*, but did not cause its actual death.

13. **Acalolepta rusticator** (Fabricius)

(Plate—VIII, figure—F & Plate—IX, figure—A)

Lamia rusticator (Fabricius. 1801. *Syst. El.*, **2** : 294. *Type-locality* : Java.

Lamila fistulator Germar, 1824. *Ins. Spec. Nov.*, 478.

Monochamus bianor Newman, 1842. *Entomologist.* **1** : 277,

Monochamus fistulator : Pascoe, 1866. *Trans. ent, Soc, Lond*, (3 **3** : 293 ; Aulmann, 1866. *Fauna Deutsch, Kol.*. **5**(3) : 19, fig. 14. ; Aurivillius, 1926. *Treubia*, **7** 2) : 103,

Dihammus rusticotor : Matsushita. 1933. *J. Fac. Agric. Hokk.*, **34**(2) : 327 ; Beeson & Bhatia, 1939 *Indian Forest Rec.* (*N. S.*) *Ent*, **5**(1) ; 68 (biology) : Breuning, 1943. *Novit, ent.*, 3me suppl., **128-133** : 462 : Gressitt, 1951. *Longicornia*, 2 : 402.

Acalol pta rusticator ; Roudon & Breuning, 1970. *Pacif. Insects Monogr.*, **24** : 465 ; Khan and Maiti, 1981. *Bull. Zool. Surv. India*, **4**(3) : 247.

Distribution :— ANDAMANS : *North Andaman* : Aerial Bay and Diglipur ; *Middle Andaman* : Bakultala and Kadamtala ; *South Andaman* : Port Blair, Garacharma, Bidnabad, Burmanallah, Wandur, Kaddalgunj, Baratang Island, Niel Island, Havelock Island, and Peel Island and *Little Andaman* : Hut Bay, Quiary and Penta (all present records).

ELSEWHERE : Indian mainland, Sri Lanka, Indonesia, Malay Archipelago, North Vietnam, Laos, China, Philippines and Samoa.

This species, although having a close similarity in size and appearance, occurs frequently in these islands than *A. andamanica.* The species is a well known pest of some seven host-plants among which only four are known from Andamans (Beeson and Bhatia, 1939). Recently, Khan and Maiti (1981) have furnished a detailed account of the host-selection, oviposition and fecundity of the species from these islands. However, all the developmental stages have been collected from freshly felled and dead logs and dead or drying trees of 10 timber yielding plants of which the following six species are recorded for the first time : *rtocarpus chaplasha, Canarium euphyllum, Pterocymbium tinctortum, Salmalia insignis, Semecarpus kurzii* and *Terminalia procera.*

Eggs are usually laid singly. However, about 7% of the egg-pits have been found to contain two eggs. The larval instars each lasts for an average of a week. Development is usually accomplished inside irregular galleries in the subcortical tissues. The larvae completely girdle the host-logs or trees, a habit which is found in no other *Acalolepta* species, nor in the other cerambycid-borers dealt with in the present communication. The gall like swelling in the vicinity of the larval galleries in the unhealthy standing trees is another unusual attribute of this species. The mature larvae mine at a depth of 3.56 to 5.11 cm inside sap-wood, where they construct their pupal chambers along the course of the wood-fibres (Plate-VIII, Fig. F). The pupal chamber of this species resembles that of *A. andamanica* and *A. admixta* in its orientation, but differs greatly in size being from 2.8 to 5.1 cm in length and from 1.2 to 1.4 cm in width. The duration of the pupal stage varies from 8 to 12 days with an average of 10 days, while the adult remains dormant for about a week. The adults emerge via an exit-hole of 0.75 to 0.89 cm in diameter. Complete development usually requires 2 to 3 months, although the species has an annual life-cycle on the mainland of India (Beeson and Bhatia, 1939).

The adults of this species are known to emerge during April and May on the Indian mainland (Beeson and Bhatia, 1939). However, in

the Andaman Islands, the adults have been found to emerge almost throughout the year, with a maximum abundance during Mid-June to July and September and a minimum during the dry months of December, January and March. The adults are nocturnal, feeding and mating in the evening and at night. The adult populations, represented by a ratio of approximately 1.4 ♀ ; 1 ♂, mostly, thrive on the bark, twigs and other green parts of a number of plants including the larval hosts. The estimated average adult longevity is 44 days under laboratory conditions.

This species is considered of minor economic impoprtance so far as the damage to the dead wood is concerned. However, the insect has been recorded as a pest of living cocoa trees (Beeson and Bhatia, 1939). In the present study, the larvae been found to attack only the unhealthy standing trees. Kalshoven (1939) reported that in East Java, in two years old teak saplings, the larvae of this species formed gall-like swellings where a circular gallery had been exacavated beneath the bark prior to their mining through the cylinder into the pith.

14. **Batocera rufomaculata** var. **andamana** Thomson

(Plate—IX, Figure—B-D).

Batocera andamana Thomson, 1878. *Revue Zool.*. (3) VI : 54. *Type-locality* : Andaman Islands.

Batocera rufomaculata DeGeer var. *Andamana* ; Kriesche, 1915. *Arch. Naturgesch. Abt.* A80 Heft 11 : 147.

Batocera rufomaculata andaman : Beeson & Bhatia, 1939. *Indian Forest Rec.* (*N. S.*) *Ent.*, 5(1) : 35 (biology).

Distribution :— ANDAMANS : *North Andaman* : Aerial Bay, Diglipur, Kshudirampur, Lakshmipur, Mayabandar and Tugapur ; *Middle Andaman* : Bakultala, Rangat, Yeretta Jetty, Long Island and Kadamtala ; *South Andaman* : Port Blair, North Bay, School line, Garacharma, Nayadera, Bidnabad, Terelybad, Burmanallah, Chidyatapu, Guptapara, Wandur, New Wandur, Port Mout, Mathura, Jirkatang, Wright Myo, Viper Island, Kalapahar, Baratang Island, Niel Island, Havelock Island and Peel Island and *Little Andaman* : Hut Bay, quiary, Ramkrishnapur, Vivekanandanagar and Penta (all present record).

ELSEWHERE : None.

Batocera rufomaculata var. *andamana* is the largest of all lamiine beetles (3,7 to 5,5 cm in length) inhabiting the islands of Andaman and

is fairly common in the area. The larvae are known to infest three timber yielding plants of considerable economic importance (Beeson and Bhatia, 1939) (for details, *vide* Table—1). In the present study, all the immature stages were cellected on several occasions from the freshly felled and dead logs and dead or dying trees of 10 important timber yielding plants. Of these the following seven species are new host records ; *Artocarpus chaplasha, Dipterocarpus* sp., *Ficus* sp., *Magifera indica, Pterocymbium tinctorium, salmalia insignis* and *Semecarpus kurzii.*

The biology and habits of this borer differ in many respects from those of the other lamiine species inhabiting the Andaman Islands. The eggs are usually laid singly, rarely in batches of two (only about 4% of the egg-pits), inside the egg-pits which are never localized in the outer bark, but occur in the phelloderm layer of the bark (Plate—IX, Fig.—B). After an incubation period of 5 to 7 days, the lavae hatch and bore down to the subcortical zone where they spend most of their life. The larval galleries are packed tightly with a coarse fibrous frass, but they differ from those of the other lamiine borers in their large size and much variable orientation. Complete larval development is accomplished in a course from 3 to 4 months and there are seven successive larval instars. Another interesting habit is that, the larvae of this species penetrate deep inside the heart-wood to a depth of from 6.41 to 10.55 cm to pupate. Such a habit is never displayed by the other lamiine species of these islands. The pupal chamber, although parallel to the wood-fibres, is largest of all the lamiine beetles of the Andamans and varies from 5.68 to 8.89 cm in length and from 2.90 to 3.79 cm in width (Plate—IX, Fig.—D). The duration of the pupal life usually varies from 14 to 22 days with an average of 16 days. The adult beetles remain dormant for about two weeks and then emerge by chewing their way out through the opposite end to the entrance-hole, leading to more or less circular exit-holes of 1.55 to 2.10 cm in diameter. Complete development usually requires 4 to 5 months and rarely it may require upto six months or even longer.

The adults are active in most of the months of the year, except Deeember and March, in the timber extraction and logging centres, timber depots and in other areas with suitable host-materials. The maximum abundance occurs during the monsoon months of June and July. The first matings usually occur 2-3 days after the emergence of the adult beetles and oviposition follows after an interval of 4-5 days. Feeding and sexual activities are usually displayed during the late afternoon with a maximum frequency at dusk. However, on two occasions, the first in January at Xaroa Creeck, Baratang Island and second in September at Garacharma, South Andaman, a number of females oviposited on some freshly felled logs of *Artocarpus chaplasha* and *Canarium euphyllum* during the day.

The adult beetles thrive on the bark and other green parts of a number of plants including the larval hosts. However, they showed a preference of feeding on the *Ficus* species in the laboratory. The adult longevity is greater than in any other species of these islands and may be more than three months with a maximum of six months in some cases under laboratory conditions.

This species is of considerable economic importance, because of the deep-boring habit of the larvae and the large larval population size resulting from the huge numbers of eggs laid during the comparatively long life-span of the adults. The species is especially important and a potential pest of the freshly felled logs in the logging centres and timber depots. The incidence of the attack to healthy trees is unknown, although on two occasions at Baratang Island, some standing unhealthy trees of *Semecarpus kurzii* were attacked by this species.

15. **Olenecamptus bilobus** (Fabricius)

(Plate—X, Figures—A-C).

Saperda biloba Fabricius, 1801. *Syst. El.*, 2 : 324. *Type-locality* : Orient ; Erichson, 1834. *Nov. Act. Nat. Cur.*, **16** suppl. 1 : 269, pl. 39, fig. 9 ; Boisduval, 1835. *Voy Astrolab. Ins.*, **2** : 527.

Olenecampus bilobus : Pascoe, 1866. *Trans. ent. Soc, Lond* (3) 3 : 316 ; Heller, 1923. *Tijdschr. Ent*, **46** : 39 ; Schwarzer. 1925. *Ent. Bl., Biol Syst Kafer* 21 : 64 ; Beeson & Bhatia, 1939. *Indian Forest Rec.* (*N. S.*) *Ent.*, 5(1) : 150 (biology ; Breuning, 1940. *Novit. ent.* 3me suppl,. **70** : 554 ; fig. 564 ; Gressitt, 1951. *Longcornia*, **2** ; 443 ; Rondon & Breuning, 1970. *Pacif. Insects Monogr.*, **24** : 479, fig. 36, e.

Olenecamptus lacteoguttatus Fairmaire, 1881. *Le Natural*, **3** : 351.

Distribution :— ANDAMANS : *North Andaman* : Aerial Bay, Kshudirampur and Tugapur ; *Middle Andaman* : Bakultala, Yeretta Jetty, Long Island and Kadamtala ; *South Andaman* : Port Blair, Garacharma, Dhanikhari, Bidnabad, Terelybad, Corbyn's Cove, Burmanallah, Chidyatapu, Mugluton, Guptapara, Line Dera, Wandur, New Wandur, Chouldhari, Ograbruj, Kaddalgunj, Ferrergunj, Mathura, Wimberlygunj, Wright Myo, Mini Bay, Panight, North Bay, Bambooflat, Viper Island, Baratang Island, Niel Island, Havelock Island and Peel Island and *Little Andaman* : Hut Bay, Quiary, Penta, No. 11 village, Vivekanandanagar and Ramkrishnapur (all present records).

ELSEWHERE : Indian mainland, Sri Lanka, Burma, Thailand, Malay Archipelago, Laos, Indo-China, China, New Guinea, Mauritius. Seychelles and Africa.

This species is one of the most common shallow sap-wood borers of the Andaman islands occurring frequently in the timber extraction and logging centres, timber stores, as well as, in forest areas. Beeson and Bhatia (1939) studied the general biology of this species on the Indian mainland and listed 18 host-plants of which 10 are confirmed as hosts in these islands. The developmental stages of this beetle have been collected from a number of host-plants, among which the following constitute new host records : *Canarium euphyllum*, *Pterocymbium tinctorium* and *Salmalia insignis*.

Khan and Maiti (1982a) have recently dealt with the detailed bionomics and life-history of this species, in these islands. The eggs are laid singly in the outer bark, inside egg-pits, made with the help of the female mandibles (Plate—X, Figure—A). However, about 3% of the egg-pits in some small logs of *Ficus carica* at Niel island, South Andaman, have been found to contain two eggs. The larvae after hatching, bore down to the subcortical tissue and excavate tiny galleries where the first moult takes place as early as the fourth day following hatching. The other larval instars each lasts for about a week. The sixth-instar larvae mine to a depth of 0.92 to 4.39 cm inside the wood and pupate therein. The pupal chamber, which varies from 1.2 to 2.3 cm in length and from 0.50 to 0.80 cm in width, is more or less parallel to the wood-fibres (Plate—X, Figure—C). The duration of pupal life usually varies from 10 to 17 days with an average of 12 days. The adults remain dormant for about a week and then emerge by chewing their way out through the distal end of the pupal chamber, leading to more or less circular exit-holes of 0.39 to 0.52 cm in diameter. The developmental period usually varies from two to three months (Khan and Maiti, 1982a) and may extend upto 4 months or even longer on rare occasions.

The adults occur frequently in the Andaman islands throughout the year with a maximum abundance during June to September and a minimum during December to February. The first matings usually occur 2-3 days after emergence and oviposition follows 4-5 days thereafter. Mating, oviposition and feeding activities occur during the evening and at night. The adults are strongly attracted to artificial light. During the day, the beetles remain inactive in cool and shady areas. The adults obtain their nourishment by gnawing the fresh green leaves and twigs or bark of a number of plants including the larval hosts. However, they showed a clear preference of feeding on *Ficus religiosa* in the laboratory. Interestingly

enough, in the emerging population, the females are observed to outnumber the males by 2 : 1. The estimated average adult longevity is 11 days under laboratory conditions.

This species is of reduced economic importance, since larval damage is restricted to the outer layers of the wood. However, the species has been reported as an occasional pest of the cultivated 'fig' (Beeson and Bhatia, 1939) on the Indian mainland. On some occasions, the borer attacks living *Ficus carica* trees on different islands of Andaman.

16. **Xenolea tomentosa** (Pascoe)

Aeschopalaea tomentosa Pascoe, 1864. *Trans. ent. Soc. Lond.*, (3)**3** : 25, *Type locality* : Malacca.

Xenolea tomentosa : Lacordaire, 1872. *Gen. Col.*, **9** : 460 ; Beeson & Bhatia, 1939. *Indian Forest Rec. (N. S.) Ent.*, **5**(1) : 188 (biology) ; Breuning, 1950. *Longicornia*, **1** : 273 ; Duffy, 1968. *Imm. Stages Orient. Timb. Beetles*, 294 p.

Distribution :— ANDAMANS : *South Andaman* : Port Blair, Guptapara, Line Dera, Baratang Island and Niel Island. (all present records).

ELSEWHERE : Thailand, Sumatra, Singapore, Malacca, Formosa, Indo-China, China, Celebes and Japan.

Xenolea tomentosa is fairly common in the islands of Andaman. Beeson and Bhatia (1939) showed that it breeds in the logs of *Pterocarpus dalbergioides* in these islands. However, a few new hosts are recorded here. These are *Ficus carica*, *F. religiosa*, *Lannea coromandelica* and *Tectona grandis*.

Eggs are laid singly inside egg-pits in the outer layer of the bark. After an incubation period of 4 to 5 days, the larvae hatch and bore through the bast and start feeding on the cortical tissues, where the first moult takes place as early as the fifth day following eclosion. After a short period of feeding on the cortical tissues, the second-instar larvae reach the subcortical zone where the remaining of the larval life is spent. The other larval instars are each of about 7 days duration. The larval galleries are very irregular. Pupation usually takes place from 0.89 to 1.6 cm below the wood-surface inside small pupal chambers of from 0.71 to 0.95 cm in length and from 0.41 to 0.47 cm in width.

The pre-pupal tunnel is usually short. However, in a few instances, particularly in smaller branches with heavy infestations, the larval galleries and pre-pupal tunnels have been observed to extend a long way inside the wood before ending as pupal chambers. The larval galleries and pre-pupal tunnels are always packed tightly with a mixture of fine fibrous and powdery frass. Pupal development requires 10-16 days. After an average period of a week in dormancy, the adults emerge by widening and cleaning their passage through the entrance-hole of the larva. Complete development usually requires from two to three months or sometimes even longer.

Beeson and Bhatia (1939) showed that adults of *X. tomentosa* are emerged during the period between May and September, but mainly during the month of July. However, the present study reveals that swarming of the adults continues throughout the year with a maximum frequency during Mid-June to September and a minimum during dry months of January and February. The first matings usually occur a day after adult emergence and subsequent feeding. Feeding, mating and oviposition occur during the period from the dusk to late evening and may continue upto midnight. However, in some field sites, some beetles have been observed in active oviposition during early morning and late afternoon. During the day, the adults shelter in cool, moist and dark places. The beetles usually obtain their nourishment by gnawing the bark of a number of plants including the larval hosts. However, they showed a clear preference for feeding on the *Ficus* spp. in the laboratory. The estimated average adult longevity is 23.7 days under laboratory conditions.

Since the larvae are very shallow borers, their damage is restricted to the surface layers of the wood. They have not been recorded to attack living trees.

17. Exocentrus (Camptomyme) alboscutellaris Breuning

Exocentrus (Camptomyme) alboscutellaris Breuning, 1966. *Indian Forest Rec.* (*N. S.*) *Ent.*, 9(2) : 15-16. *Type-locality* : Andaman islands ; Breuning, 1968. *Bull. Br. Mus. nat. Hist. Ent.*, 7(6) : 271.

Distribution :— ANDAMANS : *South Andaman* : Port Blair, Bidnabad, Shippighat, Wimberlygunj and Kadakachan and *Little Andaman* : Hut Bay and Vivekanandanagar (all present records).

ELSEWHERE : None.

Exocentrus (*Camptomyme*) *alboscutellaris*, a tiny beetle, is restricted to the Andaman islands and breeds frequently in small dry branches and stems of only a few host-plants. No biological information is available in the literature. In the present study, the species was mostly collected from the felled dry logs of *Samanea saman* and *Tectona grandis* and also from some unknown climbers.

Oviposition occurs in the outer bark inside egg-pits. the openings of which are sealed with a resinous substance. Ova are usually laid singly, but on one occasion at Kadakachan about 2.5% of the egg-pits on a very small log of *Samanea saman* have been found to contain two eggs. The incubation period varies from 5 to 9 days. The newly hatched larvae penetrate down to the phelloderm layer of the bark excavating extensive galleries and ultimately reach deep inside the sap-wood. The larvae have five successive instars and total development requires from two to four months or even longer. Pupation takes place at various depths from 2.3 to almost 6 cm in the infested branch or stem. The pupal chamber is the smallest of those species dealt with in the present monograph and usually varies from 0.52 to 0.75 cm in length and from 0.34 to 0.43 cm in width. The duration of the pupal stage usually varies from 10 to 25 days with an average of about two weeks. The adults remain dormant for about 10 days before they emerge by chewing their way out through the overlying wood and bark, leading to more or less circular exit-holes of 0.31 to 0.40 cm in diameter. Complete development usually requires a period from three to six months or even longer.

Adult emergence occurs almost throughout the year, except during the months of January to March and maximum abundance occurs from Mid-June to Mid-September. The first matings occur about a day after the newly emerged adults have fed. Without food the newly emerged adults are slow to commence sexual activities. Oviposition occurs about 4-5 days after mating. Feeding, mating and oviposition continue throughout the day with maximum frequency in the morning and afternoon hours. The adults obtain nourishment by gnawing the bark of the tender branches of a number of plants including the larval hosts. The average adult longevity has been estimated at 29 days under laboratory conditions.

The larvae are shallow borers in small dry branches and stems and are, therefore, of little economic importance. Living trees are rarely infested by this species in these islands.

18. Glenea (Stiroglenea) andamanica Breuning

(Plate—X, Figures—D & E)

Glenea (Stiroglenea) andamanica Breuning, 1958. *Ent. Arb. Mus. Frey*, **9** : 880. *Type-locality* : Andaman Islands : North Andaman.

Distribution :— ANDAMANS : *North Anadaman* : Diglipur, Kshudirampur, Mayabandar and Tugapur ; *Middle Andaman* : Bakultala, Yeretta Jetty and Kadamtalala ; *South Andaman* : Garacharma, Nayadera, Terelybad, Bidnabad, Burmanallah, Guptapara. Wandur, New Wandur, Mathura, Wright Myo, Baratang Island, Niel Island and Peel island and *Litile Andaman* : Hut Bay, Quiary, Ramkrishnapur, Vivekanandanagar, Penta and No. 22 Timber extraction Centre (all present records),

ELSEWHERE : None.

Glenea (Stiroglenea) andamanica is recorded here for the first time since its discovery in 1958. It is a common borer especially in the timber extraction coupes and logging centres inside the forest areas of these islands. The felled logs of *Pterocymbium tinctorium* of different ages are most susceptible to attack by this borer. All the developmental stages of this species are recorded on numerous occasions in different areas of the islands.

Ova are usually laid singly. However, only 1.5% of the egg-pits contain two eggs. Entire development from egg to adult takes place inside galleries and chambers which are mostly situated between the inner layers of the bark and superficial layers of the wood of the host-logs. The larval instars each has an average duration of about a week. The full grown larvae pupate in the pupal chambers, measuring from 2.13 to 3.04 cm in length and from 0.81 to 0.94 cm in width, usually located at a depth ranging from 0.91 to 1.80 cm inside the wood (Plate-X, Fig. D). However, on one occasion at Little Andaman, some pupal chambers of this species have been found localised in the inner layers of the bark. In this log the population of the immature stages was considerably higher than the other normal cases, in which the pupal chambers were confined to the sap-wood. Complete development usually requires about two months or slightly longer, of which on an average the larva takes about 42 days, pupa 9 days and dormant adult 7 days. However, these periods may vary depending upon the conditions of the host and some other undetermined factors. There are at least three generations per year.

Emergence of the adults occurs almost throughout the year with maximum frequencies from June to July and from October to November. The newly emerged adults feed before mating which usually takes place about 12 hours after emergence. The sexual and feeding activities continue from dusk until the next morning. The beetles are inactive during day and shelter in cool, moist and shady areas. The tender bark and twigs of only a few plants constitute the main food of the adults. The beetles survive with food for about 36 days under laboratory conditions.

The larvae infest dead or dying logs or trees. The damage caused by the larvae of this species is restricted to the outer layers of the wood down upto a depth of 1.68 cm from the bark surface. No instance of damage to the standing healthy trees has so far been observed.

19. Serixia (s. str.) andamanica Gardner

(Plate—X, Figure—F)

Serixia andamanica Gardner. 1930. *Indian Forest Forest Rec.*, 14(7) ; 30, Pl. 1. fig. 6, 7 & 9. *Type-locality :* North Andaman ; Beeson and Bhatia, 1939. *Indian Forest Rec. (N. S.) Ent.*, 5(1) : 173 (biology) ; Duffy, 1968. *Imm. Stages Orient. Timb. Beetles*, 348 p.

Distribution :— ANDAMANS : *North Andaman* : Diglipur, and Mayabandar ; *South Andaman* : Wandur and *Little Andaman* ; Penta, No. 11 Timber Extraction Centre and Dugon Creek (all present records).

ELSEWHERE : *Nicobars* : Car Nicobar (Beeson and Bhatia, 1939).

Beeson and Bhatia (1939) recorded this endemic species on a few occasions from *Myristica andamanica* in the islands of North Andaman and Car Nicobar. In the present study, all the developmental stages of this species were collected from the felled logs of the above mentioned host-plant on many occasions while from those of *Terminalia bialata* on only three occasions in the Little Andaman. *Terminalia bialata* constitutes the new host record of the borer.

Ova, laid singly inside egg-pits in the outer bark, require 4 to 5 days to hatch. The larval development is accomplished through five successive instars each with an average duration of about 10 days.

Mature larvae penetrate slightly deeper inside the wood for pupation as compared to those of *Glenea (Stiroglenea) andamanica*. The pre-pupal tunnel is also longer than that of *G. (Stiroglenea) andamanica*. The pupal period lasts from 9 to 17 days with an average of 13 days. The pupal chambers measure from 1.00 to 1.50 cm in length and from 0.50 to 0.70 cm in width and the openings are usually closed tightly with wood-fibres (Plate-X, Fig. F). The adults remain dormant for about 9 days before they emerge by widening and cleaning their passage through the entrance-holes of the larvae. Complete development usually requires a period from two and a half to four months or rarely even longer.

Beeson and Bhatia (1939) reported the emergence period of this beetle from April to May. However, during the course of the present study, adult emergence occurred from January to March and also from June to November, with a maximum abundance during Mid-May to late-August. The first matings occurs 8 to 12 hours after feeding of the newly emerged beetles and oviposition follows 3 to 4 days thereafter. The sexual and feeding activities occur during the afternoon and may be continued upto the evening. The adult beetles usually thrive by gnawing the bark of a number of plants, especially of the larval hosts. However, in the laboratory, they have been observed to prefer different parts of *Myristica andamanica*. The estimated average adult longevity is 31 days under laboratory conditions. However, one female has been found to survive 43 days in captivity during the months of June and July, 1979.

The larvae are shallow borers of reduced economic importance, since their damage is restricted to the outer 3 cm of the wood. They do not infest living healthy trees.

VII. ECOLOGICAL INVESTIGATION

There is no doubt that the survival potentiality of all the wood-boring insects including the cerambycid-beetles has certainly increased by the characteristic biological features and unique ecological adjustment with the physico-chemical changes of wood-hosts. The present paper is primarily devoted to examine some of the bioecological peculiarities of these borers with the aim of finding some clue, the manipulation of which may keep their population below the threshold level of their damage. Biological features of these borers have been discussed in the earlier chapter, while some general ecological observations have been taken into account in the following chapters. The ecological investiga-

tions incorporated in the present communication are limited only to the borer-host interaction with particular reference to oviposition and larval development, host-preference, frequency of infestation, intensity of population, etc., in relation to the changing conditions of the wood during its progressive drying and decay in different hosts.

(a) *Host-range :*

The selection of the appropriate host is one of the most vital issues for the successful development and proper growth of cerambycid-larvae as also in other insects. The problems of host-selection, host-specificity and host-range, although interrelated, are not necessarily the same phenomena and remain mostly inconclusive, studied so far in cerambycid-beetles due to many reasons (Linsley, 1959). However, all these problems have been examined in respect of some 30 species occurring in the islands of Andaman as far as practicable in the present paper. Among the species, some are polyphagous in contrast to many a monophagous and oligophagous ones. The majority of the species, dealt with in the present communication, obviously interfere with the felled logs or stored timber, while only some eight species infest live unhealthy trees in the forest stands. These species are ***Xystrocera globosa***, ***Aeolesthes*** (*s. str.*) ***holosericea***, ***Plocaederus obesus***, ***Pharsalia*** (*Cyrus*) ***subgemmata***, ***Epepeotes***, ***Acalolepta rusticator***, ***Batocera rufomaculata*** var. ***andamana*** and ***Olenecamptus bilobus***.

A list is appended in order to indicate the host-range of different borers occurring in these islands (Table—1). The dry wood-borer, *Stromatium barbatum*, appears to be the most polyphagous species infesting some 35 host-plants including the excessively dry ones in storage. The other polyphagous species of the subfamily Cerambycinae include *Aeolesthes* (*s. str.*) *holosericea* (14 host-plants), *Plocaederus obesus* (14 host-plants), *Xystrocera globosa* (6 host-plants), etc. The only monophagous species among the cerambycine borers is *Halme caerulescens*. On the other hand, the lamiine beetles, in general, show a narrower range of hosts as compared to that of the cerambycine beetles. *Acalolepta rusticator* has been considered as the most polyphagous among the lamiine species recorded so far from some 14 host-plants. The other polyphagous lamiine beetles include *Olenecamptus bilobus* (12 host-plants), *Batocera rufomaculata* var *andamana* (10 host-plants), *Acalolepta andamanica* (7 host-plants), etc. Among the species with a still narrower range of hosts, *Exocentrus* (*Camptomyme*) *alboscutellaris* (2 host-plants) and *Serixia* (*s. str.*) *andamanica* (2 host-plants) are recognised, while *Glenea* (*Stiroglenea*) *andamanica* is the only monophagous lamiine beetle recorded so far from these islands.

Table—1 Host range of cerambycid-borers of the islands of Andaman.

Name of the Borer - species	Name of the Host - plants
Subfamily : Prioninae	
1. *Rhaphipodus* (*s. str.*) *andamanicus* Gahan	*Parishia insignis* Hook, *Pterocymbium tinctorium* Merrill, *Salmalia insignis* Schott & Endl., *S. malabarica* (Dc) Schott & Endl) and one other unknown species.
2. *R.* (*Remphan*) *hopei* (Waterhouse)	*Dipterocarpus* species.
Subfamily : Cerambycinae	
1. *Xystrocera globosa* (Olivier)	*Albizzia chinensis* (Osbeck) Merr., *A. lebbek* Benth., *A. Procera* Benth., *Bauhinia* sp., *Salmalia malabarica* (Dc) Schott & Endl and *Samanea saman* (Jacq,) Merr.
2. *Stromatium barbatum* (Fabricius)	*Acacia pennata* Willd., *Aegle marmelos* (Linn.) Correa, *Albizzia chinensis* (Osbeck) Merr., *A. procera* Benth., *Artocarpus lakoocha* Roxb., *Bambusa* sp., *Bauhinia* sp., *Briedelia tomentosa* Bl., *Carallia brachiata* (Lour.) Merr., *Cassia fistula* Linn., *C. nodosa* Ham., *C. siamia* Lam. Vern, *Casuarina equisetifolia* (Linn.) Forst, *Citrus aurantium* Linn. (cultivated), *C. maxima* (Burm.) Merr. *C. medica* Linn., *Dalbergia volubilis* Roxb., *Dipterocarpus* sp., *Excoecaria agallocha* Linn. *Ficus carica* Linn., *F. hispida* Linn. f., *F. retusa* Linn. *F. rumphii* Blume, *Garuga pinnata* Roxb., *Lannea coromandelica* (Houtt.) merr. *Mallotus philippinensis* Mull. Arg., *Mangifera indica* Linn., *M. andamanica* King, *Murraya paniculata* (Linn.) Jack., *Pongamia pinnata* (Linn.) Merr., *Pterygota alata* (Roxb.) R. Br., *Terminalia bellirica* Roxb., *T bialata* Steud, *Xylocarpus granatum* Keon and *X. molluccensis* (Lam.) Roem.

Table-I (Contd.)

Name of the Borer-species	Name of the Host plants
3. *Aeolesthes (s. str.) holosericea* (Fabricius)	*Aegle marmelos* (Linn.) Correa, *Cynometra ramiflora* Linn., *Dracontomelum mangiferum*, Bl., *Duabanga sonneratioides* Buch-Ham, *Lannea coromandelica* (Houtt) Merr., *Mangifera indica* Linn., *M. andamanica* King, *Prunus javanica* (T. & B.) Miq., *Rhizophora* spp., *Salmalia insignis* Schott & Endl., *S. malabarica* (Dc) Schott & Endl., *Tectona grandis* Linn., *Terminalia bellirica* Roxb. and *T procera* Roxb.
4. *Plocaederus obesus* Gahan	*Artocarpus chaplasha* Roxb., *Canarium euphyllum* Kurz, *Garuga pinnata* Roxb., *Lannea coromandelica* (Houtt.) Merr., *Mangifera andamanica* King, *M. indica* Linn., *Pterocymbium tinctorium* Merr., *Salmalia insignis* Schott & Endl,, *S. malabarica* (Dc) Schott & Endl, *Spondias pinnata* (Linn. f.) Kurz, *Pterygota alata* (Roxb), R. Br., *Sterculia colorata* Roxb., *S villosa* Rox b. and *Tetrameles nudiflora* R. Brown.
5. *Ceresium andamanicum* Gahan	*Artocarpus lakoocha* Roxb. *Ficus gomeziana* Wall., *F. carica* Linn. and *Planchonia andamanica* King,
6. *C. flavipes* (Fabricius)	*Casuarina equisetifolia* (Linn) Forst and *Rhizophora apiculata* Bl.
7. *C. geniculatum* White	*Artocarpus lakoocha* Roxb., *Lagerstroemia hypoleuca* Kurz and *Terminalia manii* King.
8. *Xylotrechus buqueti* (Laporte & Gory)	*Cassia fistula* Linn., *Dipterocarpus* sp., *Duabanga sonneratioides* Buch.-Ham. *Lagerstoemia* sp., *Myristica longifolia* Wall., *Pterocarpus dalbergioides* Roxb. and *Tectona grandis* Linn.
9, *Halme caerulescens* Gahan	*Teminalia manii* King.

Table 1 (*Contd.*)

Name of the Borer-species	Name of the Host-plants
Subfamily : Lamiinae	
1. *Clyzomedus annularis* Pascoe	*Canarium euphyllum* Kurz, *Ficus* sp. *Mangifera indica* Linn., *M. sylvatica* Roxb. and *Semecarpus kurzii* Engler.
2. *Coptops rufa* Thomson	*Canarium euphyllum* Kurz, *Ficus* sp., *Pterocymbium tinctorium* Merr. and *Samanea saman* (Jacq.) Merr.
3. *Ropica honesta* m. *rufescens* Pic	*Ficus* sp., *Lannea coromandelica* (Houtt.) Merr., *Pongamia pinnata* (Linn.) Merr., *Salmalia malabarica* (DeCand.) Scott & Endl. and *Samanea saman* (Jacq.) Merr.
4. *Pterolophia* (*s. str.*) *andamanica* Breuning	*Albizzia lucida* Benth., *A. lebbek* Benth., *Duabanga sonneratioides* Buch.-Ham *Ficus* sp., *Samanea saman* (Jacq.) Merr. and *Mimusops littoralis* Kurz.
5. *P.* (*s. str.*) *pallidifrons* Breuning	*Mimusops littoralis* Kurz, *Samanea saman* (Jacq.) Merr. and *Pterygota alata* (Roxb.) R. Br.
6. *P.* (*s. str.*) *sterculiae* Breuning	*Aegle marmelos* (Linn.) Correa, *Ficus religiosa* Linn. and *Pterygota alata* (Roxb.) R. Br.
7. *Desisa* (*Cylindrostyrax*) *marmorata* Breuning	*Cassia fistula* Linn., *Pterocarpus dalbergioides* Roxb. and *Tectona grandis* Linn.
8. *Mispila* (*s. str.*) *venosa* m. *augularis* Pascoe	*Cassia fistula* Linn., *Ficus* sp., *Pterygota alata* (Roxb.) R. Br. and one Unidentified climber.
9. *Pharsalia* (*Cycos*) *subgemmata* (Thomson)	*Canarium euphyllum* Kurz, *Garuga pinnata* Roxb., *Mangifera andamanica* King., *M. indica* Linn., *M. sylvatica* Roxb. and *Spondias pinnata* (Linn. f.) Kurz,
10. *Epepeotes* sp.	*Artocarpus chaplasha* Roxb., *Canarium euphyllum* Kurz, *Ficus religiosa* Linn., *Mangifera indica* Linn., *Semecarpus kurzii* Engl. and one unknown climber.

Table 1 (*Contd.*)

Name of the Borer-species	Name of the Host-plants
11. *Acalolepta andamanica* (Breuning)	*Anacardium occidentale* Linn., *Artocarpus chaplasha* Roxb.. *Canarium euphyllum* Kurz, *Pterocymbium tinctorium* Merr., *Salmalia insignis* Schott & Endl., *Semecarpus kurzii* Engl. and *Terminalia procera* Roxb.
12. *A. admixta* (Gahan)	*Pterocarpus dalbergioides* Roxb. and *Pterospermum acerifolium* Willd.
13. *A. rustieator* (Fabricius)	*Aegle marmelos* (Linn.) Correa, *Artocarpus chaplasha* Roxb., *A. integrifolia* Linn. f., *Canarium euphyllum* Kurz, *Citrus maxima* (Burm.) Merr., *Erythrina variegata* Linn., *Instsia bijuga* (Colebr.) O. Ktze., *Ficus religiosa* Linn , *Ficus* sp., *Pterocymbium tinctorium* Merr., *Semecarpus kurzii* Engl. and *Tectona grandis* Linn.
14. *Batocera rufomaculata* var. *andamana* Thomson	*Artocarpus chaplasha* Roxb., *Canarium euphyllum* Kurz, *Dipterocarpus* sp. *Ficus bengalensis* Linn., *Ficus* sp., *Mangifera indica* Linn., *Parishia insignis* Hook, *Pterocymbium tinctorium* Merr., *Salmalia insignis* Schott & Endl. and *Semecarpus kurzii* Engl.
15. *Olenecamptus bilobus* (Fabricius)	*Artocarpus chaplasha* Roxb., *A. integrifolia* Linn. f., *Canarium euphyllum* Kurz, *Ficus bengalensis* Linn., *F. carica* Linn., *F. infectoria* Roxb., *F. religiosa* Linn., *Mangifera andamanica* King, *M. indica* Linn., *Pterocymbium tinctorium* Merr., *Salmalia insignis* Schott & Endl. and *S. malabarica* (DeCand.) Schott & Endl.
16. *Xenolea tomentosa* (Pascoe)	*Ficus carica* Linn., *F. religiosa* Linn., *Lannea coromandelica* (Houtt) Merr., *Pterocarpus dalbergioides* Roxb. and *Tectona grandis* Linn.
17. *Exocentrus* (*Camptomyme*) *alboscutellaris* Breuning	*Samanea saman* (Jacq.) Merr. and *Tectona grandis*Linn.
18. *Glenea* (*Stiroglenea*) *andamanica* Breuning	*Pterocymbium tinctorium* Merr.
19. *Serixia* (*s. str.*) *andamanica* Gardner	*Myristica andamanica* Hook and *Terminalia bialata* Steud.

(b) *Frequency of Infestation :*

Usually, species infesting a wide range of host-plants are considered to be of economic importance. In addition, the frequency of infestation of the borer in different hosts must be taken into account. With this view, the felled logs of 20 timber yielding plant-species of different age were examined during the last three years in the timber extraction coupes, logging centres and timber depots of the Andamans. The results for 15 cerambycid-species are shown in Table—2.

The results indicate that *Plocaederus obesus* infests about 89% of the felled logs of *Tetrameles nudiflora*, 83% of *Salmalia insignis*, 47% of *Salmalia malabarica* and only 19% of *Semecarpus kurzii*. Likewise, *Aeolesthes* (*s. str.*) *holosericea* attacks about 90% of the logs of *Salmalia malabarica*, 83% of *Terminalia procera*, 39% of *Salmalia insignis* and only 8% of *Tectona grandis*. The detailed examination of the data presented in Table—2 will indicate the relative preference for and abundance of the 15 species in different hosts. In addition, the table shows the relative susceptibility of the hosts to attack by different borers. The logs of *Salmalia insignis* and *Canarium euphyllum* seem to be most susceptible to attack by seven out of the 15 borers, while those of *Pterocymbium tinctorium* and *Semecarpus kurzii* occupy the second position in being attacked by six borer-species. The only species, *Terminlia bialata* seems to be least susceptible to attack by the borers, as it is attacked by only one species, the polyphagous *Stromatium barbatum*. *Salmalia insignis, Canarium euphyllum* and *Pterocymbium tinctorium* are soft-wooded species and it is possible that their thick bark may retain moisture for a longer period thus creating a suitable environment for the development of many cerambycid-species. *Terminalia bialata*, on the other hand, with its hard wood and thin bark seems to be rather unsuitable host.

Table—2. Percentage of the felled logs of 20 different timber species by 15 cerambycid species in the timber extraction centres and timber depots.

Timber species	% of logs infested *														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Albizza chinensis	—	—	49.3	27.7	—	—	—	—	—	—	—	—	—	—	—
Artocarpus chaplasha	—	—	—	—	—	65.1	—	—	—	—	7.8	72.3	68.9	91.0	—
A. lakoocha	—	—	—	19.6	—	—	43.5	—	—	—	—	—	—	—	—
Salmalia malabarica	11.71	—	39.8	—	89.63	47.11	—	—	—	—	—	—	—	53.4	—
Canarium euphyllum	—	—	—	—	—	79.03	—	—	43.3	54.9	13.03	31.71	44.77	39.8	—
Cassia fistula	—	—	—	23.6	—	—	—	35.31	—	—	—	—	—	—	—
Dipterocarpus species	—	29.67	—	13.25	—	—	—	24.90	—	—	—	—	9.14	—	—
Lannea coromandelica	—	—	—	9.21	59.46	56.0	—	—	—	—	—	—	—	—	40.66
Parishia insignis	49.86	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pterocarpus dalbergioides	—	—	—	—	—	—	—	41.02	—	—	—	—	—	—	59.71
Pterocymbium tinctorium	19.31	—	—	—	—	73.14	—	—	—	—	6.12	57.32	53.8	2.63	—

Table 2 (contd.)

Timber species	% of logs infested*														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Salmalia insignis	27.0	—	—	—	39.53	83.23	—	—	—	—	12.13	73.85	42.8	82.65	—
Semecarpus kurzii	—	—	—	—	—	19.33	—	—	3.14	43.81	37.55	11.71	69.02	—	—
Spondias pinnata	—	—	—	—	—	50.44	—	—	23.4	—	—	—	19.0	—	—
Pterygota alata	—	—	—	7.32	—	71.33	—	—	—	—	—	—	—	—	—
Tectona grandis	—	—	—	—	8.03	—	—	37.31	—	—	—	4.14	—	—	54.11
Terminalia bialata	—	—	—	12.15	—	—	—	—	—	—	—	—	—	—	—
T manii	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
T. procera	—	—	—	—	83.72	—	—	—	—	—	81.17	—	—	—	—
Tetrameles nudiflora	—	—	—	—	—	88.83	—	—	7.01	—	—	—	—	—	—

* 1. Name of the borer species :- 1. *Rhaphipodus* (*s. str.*) *andamanicus*, 2. *R.* (*Remphan*) *hopei*, 3. *Xystrocera globosa*, 4. *Stromatium barbatum*, 5. *Aeolesthes* (*s. str.*) *holosericea*, 6. *Plocaederus obesus*, 7. *Ceresium andamanicum*, 8. *Xylotrechus buqueti*, 9. *Pharsalia* (*Cycos*) *subgemmata*, 10. *Epepeotes* sp., 11. *Acalolepta andamanica*, 12. *A. rusticator*, 13. *Batocera rufomaculata* var. *andamana*, 14. *Olenecamptus bilobus*, 15. *Xenolea tomentosa*.

(c) *Relative Preference of Host for Ovipostion :*

The aggregation of adult beetles around freshly felled logs in the timber extraction and logging centres of the islands of Andaman is a common occurrence, particularly in the breeding season. The aim of such aggregation seems to be to secure suitable oviposition sites in the host-material. Although, the females visited all the available timber species, they only oviposited in their preferred hosts.

The relative preference for the different hosts for oviposition by the cerambycid species was investigated. A field experiment was carried out in two different months with some host-logs of almost similar condition and situaton in two isolated forest areas of South Andaman.

Five specimens of each of the six tree species, *Artocarpus chaplasha*, *Canarium euphyllum*, *Pterocymbium tinctorium*, *Salmalia malabarica*, *Semecarpus kurzii* and *Terminalia procera* were felled on 5th June, 1979 in Dhanikhari Forest and again on 9th September, 1979 in the Garacharma Forest, South Andaman. The number of adult beetles of the different species active on these freshly felled logs, as well as, the number of females ovipositing on the different logs were recorded daily during the period from 8th June to 12th July at Dhanikhari and from 12th September to 30th October, 1979 at Garacharma. The location, direction, condition and maintenance of the host-logs were similar in both the localities. Table—3 shows the average number of adults which visited the logs and the number of females which oviposited on the individual host-logs during the period of observation. Amongst many a cerambycid-species, *Aeolesthes* (s. *str.*) *holosericea*, *Plocaederus obesus*, *Pharsalia* (*Cycos*) *subgemmata* and *Acalolepta andamanica* were the commonest ones in the experimental centres. They visited almost all the available host-logs (*vide*, Table—3) but oviposited only in a few logs in a clear order of preference.

The detailed scrutiny of the Table—3 will indicate that most of the females of *Plocaederus obesus* oviposit in *Canarium euphyllum*, a few in *Salmalia malabarica*, whilst no eggs are laid in *Terminalia procera*. However, the last species is one of the most preferred hosts for oviposition by *Aeolesthes* (*s. str.*) *holosericea* and *Acalolepta andamanica*. The females of *Aeolesthes* (*s. str.*) *holosericea* seem to prefer the logs of *Terminalia procera* to others during both the monsoon and post-monsoon periods. Similarly, *Pharsalia* (*Cycos*) *subgemmata* prefers *Canarium euphyllum*, while *Acalolepta andamanica* prefers *Terminalia procera* and *Canarium euphyllum* to the other host-plants, whilst *Salmalia malabarica* is avoided by both the borers. It is interesting to note that the

preference for oviposition is very similar in both the periods, i. e., in July and September.

Further, the same host, ***Terminalia procera***, for example, is the preferred host for the oviposition of *Aeolesthes* (*s. str.*) *holosericea* and *Acalolepta andamanica*, but most unsuitable for *Plocaederus obesus*. Likewise, *Canarium euphyllum* and *Semecarpus kurzii* are most preferred by all the above mentioned borers except *Aeolesthes* (*s. str.*) *holosericea* which has got stronger affinity for *Terminalia procera* and to some extent for *Salmalia malabarica*. However, such oviposition preference depends upon the inherent characteristics of the borer-species, as well as, the condition of the host-material. It can be seen that the oviposition preference is similar in the monsoon and post-monsoon periods and does not drastically alter with the season.

In this connection, a pertinent question is whether the males are also visiting the logs and if so, why do they visit. Although, males in general are hardly influenced by the presence of suitable and sufficient oviposition-material (Hosking and Bain, 1977 ; Khan and Maiti, 1982a) a small number of individuals of the different species are also visiting the host-logs in association with the ovipositing females. Their occurrence may be due to the aggregation of a considerable number of females in the area for a long time (Hosking and Bain, 1977 ; Khan and Maiti, 1982a). Moreover, some species, like, *Plocaederus obesus*, *Pharsalia* (*Cycos*) *subgemmata*, *Acalolepta* spp., etc., are occasional feeders on the bark of freshly felled larval hosts.

Table—3. Average number of adults visiting and the females ovipositing on five freshly felled trees of each of the six species during the period from June 8 to July 12 and from September 12 to October 30, 1979.

Host - plants		Average number of adults counted and females oviposited per tree							
		June 8 to July 12				September 12 to October 30			
		a	b	c	d	a	b	c	d
Artocarpus chaplasha	1.	3	27	4	7	2	23	2	9
	2.	–	6	–	1	–	4	–	1
Salmaia malabarica	1.	31	17	3	2	28	15	2	2
	2.	4	3	–	–	5	3	–	–
Canarium euphyllum	1.	7	37	30	27	4	31	36	22
	2.	–	8	7	5	–	6	5	6
Pterocymbium tinctorium	1.	4	40	3	12	3	36	2	12
	2.	–	5	–	2	–	4	–	1
Semecarpus kurzii	1.	2	29	11	31	2	27	9	30
	2.	–	4	1	2	–	3	2	3
Terminalia procera	1.	59	9	4	56	46	11	3	51
	2.	7	–	–	8	7	–	–	7

1. Average number of adults counted per tree. 2. Average number of females oviposited per tree.

(a) *Aeolesthes (s. str.) holosericea,* (b) *Plocaederus obesus,* (c) *Pharsalia (Cycos) subgemmata,* (d) *Acalolepta andamanica*

(d) *Density of Borer Populations :*

The assessment of the larval population density in the felled logs of different commercially important species is certainly important parameter affecting the relative economic importance of each pest-species. The frequency of infestation of different borers in some host-species has been discussed earlier which provide further incentive to assess the intensity of population infesting different logs of commercial importance. Table—4 presents the population density estimates, per unit-area of 25 cm × 25 cm, for 15 species of borers infesting the felled logs of 20 important timber yielding species. It is well known that the larval population size depends upon the physico-chemical condition of the hosts and the inherent characteristics of the borers, both of which are greatly influenced by a number of environmental factors. Those factors, studied in some cases, have not been included here keeping a further scope for detailed discussion elsewhere.

However, the larval population density cannot be compared with confidence unless the differences are sufficiently large. Like most of the cerambycid density figures, the significance of the figures, in this study, is reduced because of high frequency zero values and a statistical analysis could not be applied to the results.

The larval population density in different host-logs, as indicated in the present observations (Table—4), is not as high as one could expect in the islands of Andaman with their somewhat non-seasonal tropical climate. The average number of larvae per unit-area only slightly exceeds three, whatever may be condition and situation of the hosts. However, some species, namely, *Plocaederus obesus*, *Acalolepta rusticator*, *Batocera rufomaculata* var. *andamana* and *Olenecamptus bilobus* occur in compartively larger populations than the other borers in some hosts, especially in the logs of *Artocarpus chaplasha* and *Pterocymbium tinctorium*. *Aeolesthes* (*s. str.*) *holosericea* and *Acalolepta andamanica* infesting *Terminalia procera* have slightly lower larval densities than the former group. But in some other hosts, such as in *Salmalia insignis*, all these borers seem to occur in nearly equal density. Further, a higher population density is also observed in respect of some species, especially in *Pharsalia* (*Cycos*) *subgemmata* infesting the felled logs of *Canarium euphyllum* and *Acalolepta andamanica* infesting *Semecarpus kurzii*.

Table—4. Average number of larvae per unit-area (25 cm × 25 cm) of wood of the sample logs and trees.

Timber species	Average number of larvae of the borer species per unit area *1														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Albizzia chinensis	—	—	2.54	*2	—	—	—	—	—	—	—	—	—	—	—
Artocarpus chaplasha	—	—	—	—	—	1.35	—	—	—	1.10	0.11	2.10	1.47	3.31	—
A. lakoocka	—	—	—	0.21	—	—	1.33	—	—	—	—	—	—	—	—
Salmalia malabarica	0.12	—	1.03	—	1.51	0.87	—	—	—	—	—	—	—	1.19	—
Canarium euphyllum	—	—	—	—	—	1.13	—	—	2.13	1.51	0.13	0.48	1.41	0.72	—
Cassia fistula	—	—	—	0.13	—	—	—	1.43	—	—	—	—	—	—	—
Dipterocarpus species	—	0.11	—	0.17	—	—	—	0.48	—	—	—	—	0.72	—	—
Lannea coromandelica	—	—	—	*2	1.91	1.73	—	—	—	—	—	—	—	—	1.14
Parishia insignis	0.29	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pterocarpus dalbergioides	—	—	—	—	—	—	—	1.31	—	—	—	—	—	—	1.53
Pterocymbium tinctorium	0.07	—	—	—	—	3.19	—	—	—	—	0.09	1.51	1.23	0.32	—

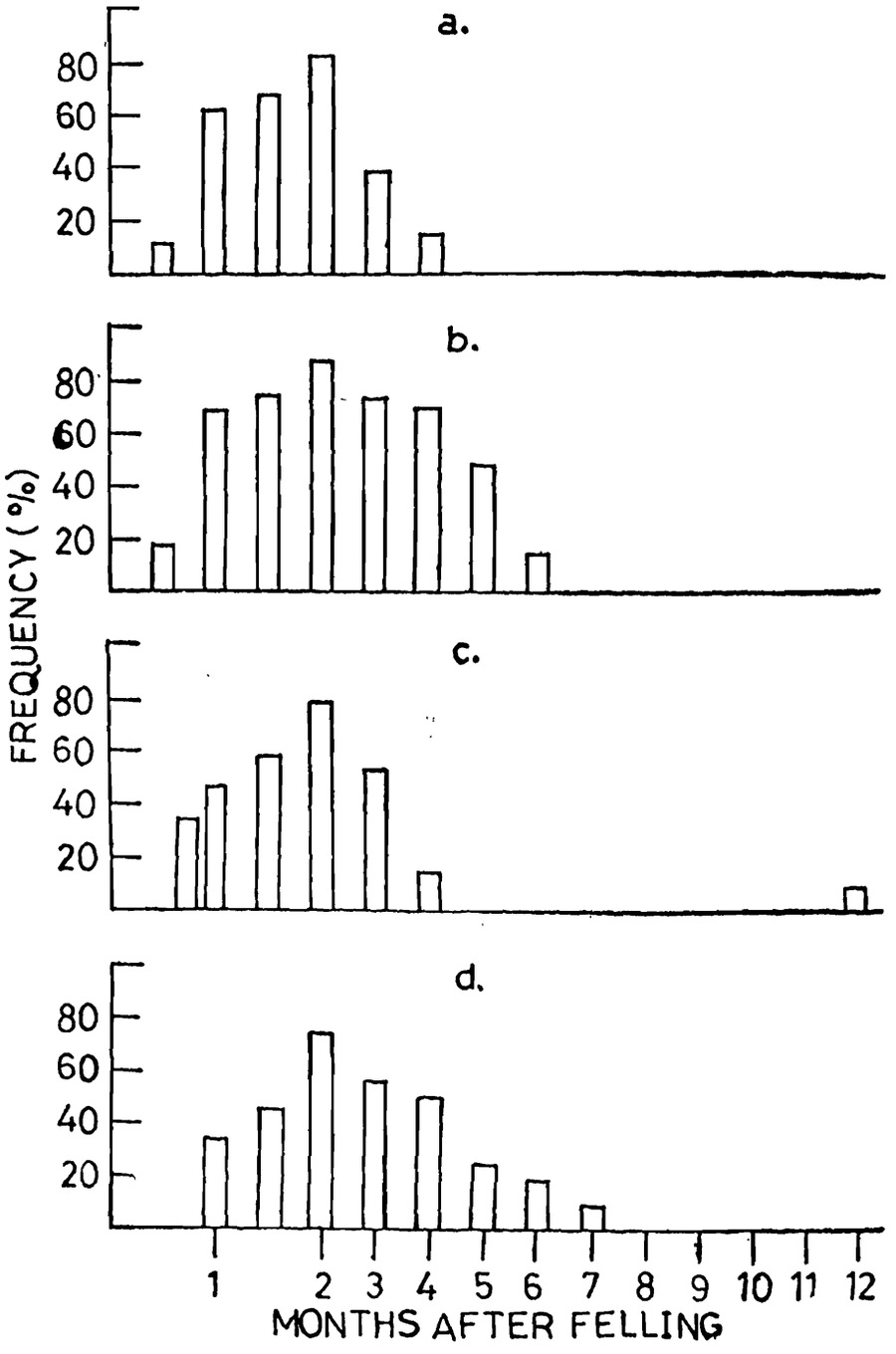
Table-4 (contd.)

Timber species	Average number of larvae of the borer species per unit area *1														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Salmalia insignis	0.19	—	—	—	1.83	2.62	—	—	—	—	1.42	1.97	1.39	2.31	—
Semecarpus kurzii	—	—	—	—	—	0.41	—	—	0.44	1.03	1.62	0.91	2.17	0.21	—
Spondias pinnata	—	—	—	—	—	1.78	—	—	1.77	—	—	—	0.66	—	—
Pterygota alata	—	—	—	0.14	—	1.71	—	—	—	—	—	—	—	—	—
Tectona grandis	—	—	—	—	0.43	—	—	1.69	—	—	—	0.03	—	—	0.69
Terminalia bialata	—	—	—	0.27	—	—	—	—	—	—	—	—	—	—	—
T manii	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
T procera	—	—	—	—	3.03	—	—	—	—	—	3.23	—	—	—	—
Tetrameles nudiflora	—	—	—	—	—	2.11	—	—	—	—	—	—	—	—	—

*1. Name of the borer species : 1. *Rhaphipodus (s. str.) andamanicus*, 2. *R. (Remphan) hopei*, 3. *Xystrocera globosa*, 4. *Stromatium barbatum*, 5. *Aeolesthes (s. str.) holosericea*, 6. *Plocaederus obesus*, 7. *Ceresium andamanicum*, 8. *Xylotrechus buqueti*, 9. *Pharsalia (Cycos) subgemmata*, 10. *Epepeotes Sp.* 11. *Acalolepta andamanica*, 12. *A. rusticator*, 13. *Batocera rufomaculata* var. *andamana*, 14. *Olenecamptus bilobus*, 15. *Xenolea tomentosa*.

*2The average number of larvae has not been determined.

However, the larval population density of a species varies within certain limits in different host-plants. For example, *Plocaederus obesus* has the highest density of 3.19 in *Pterocymbium tinctorium* and lowest of 0.41 in *Semecarpus kurzii* with different levels of density in as many as 8 other hosts (out of 20 species studied in this regard) in these islands. Similarly, *Batocera rufomaculata* var. *andamana* occurs in the highest intensity in *Semecarpus kurzii* and the lowest in *Spondias pinnata*. Thus, the detailed examination of individual borers shows the variation of larval population density in different hosts.



Figure—1. Frequency distribution of the cerambycid-borers in the felled logs of different age of four important timber yielding species ; a. *Artocarpus chaplasha* Roxb., b. *Canarium euphyllum* Kurz, *Mangifera indica* Linn. and d. *Pterocymbium tinctorium* Merr.

(e) *Oviposition in relation to the Age of the logs :*

It is well known that the fresh and green logs of different host-plants serve as the most suitable feeding and breeding material for the successful growth and development of the cerambycid-borers (Khan and Maiti, 1981a and 1982a). A pertinent question is how long a felled log remains suitable for oviposition with its progressive drying and decaying. To understand such a problem, an investigation was carried out in the different logging centres of Middle and South Andaman to assess the suitability of logs of different ages after felling for the oviposition of some borers. The histographs presented in Figure—1 (a, b, c & d) show the frequency distribution of the eggs and early instar larvae of 30 species of borers infesting the logs of some four host-species within the period of 1-12 months after felling. The preference for oviposition has been judged by the presence of a high percentage of eggs and larvae of particular species or a group of species in any given log.

However, as indicated in the histographs, more than 80% of the borers seem to show strong preference for oviposition in the logs of *Artocarpus chaplasha* and *Canarium euphyllum* upto the second month after felling. The percentage declines rapidly within the next two months in the former host, while in the latter remains quite high upto the third and fourth month, after which it declines rapidly upto 15% or so during the sixth month (Figure—1, a & b). Thus, the logs of *Canarium euphyllum* remain suitable for oviposition for a longer period from two weeks to six months after felling in contrast to those of *Artocarpus chaplasha.* Similarly, *Pterocymbium tinctorium*, a thick barked soft-wood species, remains quite hospitable to the borer's attack from the first to the seventh month after felling. In such a host, the maximum percentage of 78% of the immature stages of borers was observed in the second month with a gradual fall to 10% in the seventh month (Figure—1, d). Further, the frequency of borers in *Mangifera indica* is quite high upto about 78% in the second month but declines sharply to about 15% during the next two months. Interestingly enough, the same host remains suitable for fresh infestation by a single dry wood-borer, *Stromatium barbatum*, upto the 12th month after felling (Figure—1, c).

From the foregoing observations, it can be inferred that them two hosts, namely, *Canarium euphyllum* and *Pterocymbium tinctorium*, remain susceptible to attack by a number of species for a long period of 1-7 months. The reason may be attributed to the characteristic nature of the soft-wood as well as of the comparatively thick bark of these host-species retaining moisture for a longer span of time.

Among the borer species involved in the present study, the most important ones are *Coptops rufa*, *Clyzomedus annularis*, *Acalolepta andamanica*, *A. rusticator*, *Rhaphipodus andamanicus*, *Olenecamptus bilobus*, *Stromatium barbatum*, etc. Amongst all the species, *S. barbatum* seems to breed in comparatively older logs with excessive dryness, as observed in the logs of *Mangifera indica*, even felled as long as 12 months or so.

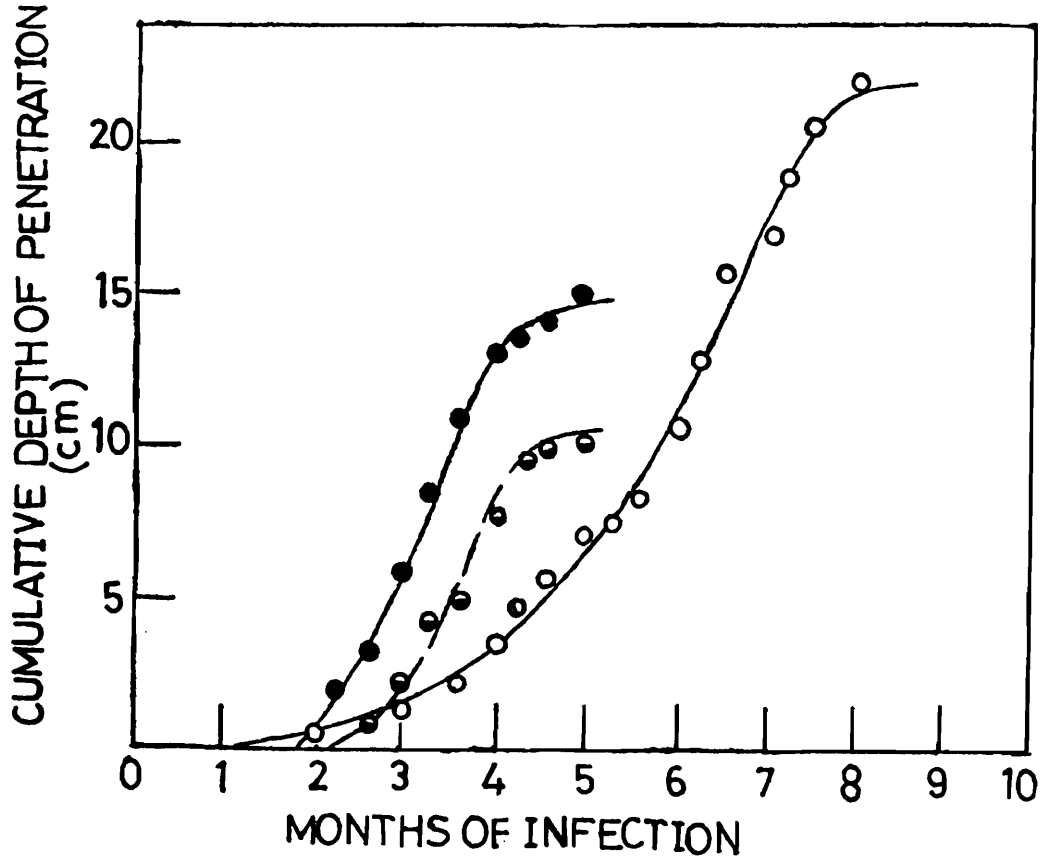
VIII. ECONOMIC IMPORTANCE

The cerambycid-borers inhabiting the islands of Andaman may most accurately be termed as 'secondary pests', since they are hardly capable of either killing healthy live host-plants or totally destroying the infested wood. The destructive propensities of these borers are limited only to the unhealthy or wounded trees and to unsuitably preserved felled logs.

On the other hand, all the cerambycid-borers are not of equal economic importance, since their destructive propensities vary from species to species as well as from host to host. The extent of damage caused by any particular species certainly depends on its feeding habits, reproductive capability and adaptive ability. Some species are polyphagous in contrast to many a monophagous and oligophagous ones, and these types may again be grouped as "shallow sapwood borers' or 'heart-wood borers', depending upon the depth of penetration into the wood. Such larval habits are normally, either related to the food requirements of the species for its proper growth and successful development or to avoidance of inter- and intraspecific competition for the same food source. However, the potential extent of damage for any borer may usually be judged from certain criteria, such as, the feeding habits, duration of larval development, frequency and preference of attack, density of larval populations, etc., which in the present communication, have been discussed in brief in the earlier chapters.

However, the majority of the species dealt in the present account, spend their entire larval life under the bark where there is least possibility of causing significant damage to the valued wood. In contrast, only a few species, namely, *Rhaphipodus* (*s. str.*) *andamanicus*, *R.* (*Remphan*) *hopei*, *Stromatium barbatum*, *Plocaederus obesus*, *Aeolesthes* (*s. str.*) *holosericea* and *Batocera rufomaculata* var. *andamana*, are of considrable economic importance, since the larvae of these species excavate enormous tunnels extending deep inside the wood and reducing the commercial value of the infested wood.

The extent of damage by a wood-boring beetle depends, obviously, on the duration of the larval life which is much influenced by the quality of the food. It is generally accepted that the larvae feeding on the inner-bark or on the subcortical tissues and fresh sap-wood containing rich food-material, have shorter developmental periods and hence remain mostly in the superficial layers of the wood. However, there is usually greater competition in such nutritionally superior layers. When the food in such layers is exhausted, the borers are compelled to penetrate deeper layers containing less rich food-material like cellulose and lignin which results in slower development and consequently a longer larval life. Figure—2 gives the cumulative depth of penetration of the larvae of *Rhaphipodus* (*s. str.*) *andamanicus*, *R.* (*Remphan*) *hopei*, *Plocaederus obesus* and *Batocera rufomaculata* var. *andamana* in some host-logs of similar dimensions. It is observed that the larvae of *Rhaphipodus* (*s. str.*) *andamanicus* and *R.* (*Remphan*) *hopei* usually take about eight months to reach their maximum depth, while those of the other two species only take 3-4 months to complete the destructive phase of the larval life. Thus, the larval feeding period or in other words the destructive phase in most of the cerambycid-borers of these islands,



Figure—2. Cumulative depth of penetration of the larvae of four most destructive species in the logs of similar dimension and age. ●——● = *Rhaphipodus* (*s. str.*) *andamanicus* and *R.* (*Remphan*) *hopei*; θ——θ = *Plocaederus obesus*; ●——● = *Batocera rufomaculata* var. *andamana*.

seems to last only 3-8 months, in contrast to 1-2 years in their allies inhabiting the mainland of India. The almost non-seasonal climatic conditions of the islands of Andaman probably has some influence in reducing the period of development of these borers.

In the Andamans, the logs in the extraction centres or in storage suffer maximum deterioration within a shorter period of time due to the interference of rapidly growing larvae. Due to lack of a proper transportation system, the rapid disposal of the extracted logs is greatly hampered and, thus, the logs are exposed to severe attack by the borers. However, for the correct analysis of the destructive propensities of each species, assessment of the value and volume of wood destroyed must be calculated. The results, dealt with in the present communication, are based mainly on the frequency of attack, depth of penetration and population density of different borers, which need further detailed investigation.

IX. DISCUSSION

Although there is remarkable uniformity in the major biological features of the borers studied in these islands, some differences are pronounced in certain species depending upon the inherent characteristic features of the borer as well as the physiographic location and micro-climatic conditions of the host-material. The most obvious differences between the species are the depth of larval penetration, shape, size and orientation of the pupal chamber, duration of the different developmental stages and total life-span, feeding and sexual behaviour, host-range and selection, etc. However, a discussion of the general biological features of these borers will be of some interest. It will, at least, provide some light on the life processes influenced by the tropical insular environment giving a scope for comparing the same with those of the species inhabiting the mainland of India.

Host-selection and Oviposition :

The selection of a suitable host as well as of oviposition sites on the selected host are probably the most vital aspects of the biology of borer-insects for their survival and propagation. Usually, an apparently suitable host-material is further tested by the impregnated females with the aid of their extruded ovipositor for the selection of the most suitable oviposition site. According to the mode of oviposition, the species may broadly be grouped into two categories, as already

been done by other authors also (Tragardh, 1930 ; Butovitsch, 1939 ; Beeson and Bhatia, 1939) :—

A. The first group deposits the eggs, usually in groups, exclusively with the aid of the ovipositor in the natural cracks and crevices on the bark or wood-surface, as observed in most of the cerambycine beetles such as, *Aeolesthes* (*s. str.*) *holosericea*, *Plocaederus obesus*, *Stromatium barbatum*, *Ceresium* spp. etc., in these islands.

B. The second group, on the other hand, oviposits inside the artificial egg-pits, excavated by the mandibles of the female, in which the eggs are pushed singly inside the bark or in between the bark and sap-wood. This method is prevalent in most of the lamiine beetles of these islands.

Gallery pattern :

On the basis of the gallery pattern only, it is very difficult to separate the borers into different distinct categories. The formation of irregular galleries is perhaps a regular feature, which are usually observed running approximately along the axis of the wood-fibres. Rarely, as with *Acalolepta rusticator*, the galleries traverse almost at right angles to the wood-fibres just girdling beneath the bark on the wood surface. However, with respect to the depth of penetration, the cerambycids of these islands are easily grouped into two categories, namely, the shallow wood-borers and heart wood-borers as already referred to earlier.

The larvae with prolonged developmental periods usually feed at greater depths, particularly in the heart-wood. Such wood-boring habits are certainly influenced by the adaptation to stronger digestive ability of the larvae with progressive age (Graham, 1925 ; Maiti, *et. al*, 1983). Apparently, only a few species, namely, *Rhaphipodus* spp., *Aeolesthes* (*s. str.*) *holosericea*, *Plocaederus obesus*, etc., have undergone such adaptation as indicated by their larval feeding habit.

Life-cycle :

The duration of the life-cycle of the cerambycid-borers varies within wide limits in the islands of Andaman. Sometimes, the individuals of a single progeny take much longer period to complete development in comparison with their closest allies. Although, a number of biotic and abiotic environmental factors undoubtedly affects the rate and duration of development, some other factors, such as, inter- and

intra-specific competition, and the physico-chemical set up of the host-material, seem to be the most important. Rapid growth rate is consistently shown by larvae feeding in the subcortical tissues. Heavy infestation with the interference of more than one species, usually results in the rapid destruction of the entire subcortical tissue and eventually the larvae are forced to move into the deeper wood. As such, when the larvae are forced out of the nutritionally superior subcortical zone at an early stage of development, growth is normally checked during the later phases resulting in delayed development. Such phenomenon has also explained by Hosking and Bain (1977) and Khan and Maiti (1982a).

Further, the length of the life-cycle of the majority of cerambycid-borers of these islands is not as widely variable as in the mainland of India. One and a half month is the shortest period as in *Pterolophia* (*s. str.*) *andamanica*, while one and a half to about two years is the longest period as observed in ceratin cohorts of *Rhaphipodus* (*s. str.*) *andamanicus* and *Stromatium barbatum*. The general trend is towards a shorter life-cycle with 2-3 generations per year. Beeson and Bhatia (1939) mentioned that the life-cycle is a fundamental characteristic rhythm of the species, rather than that of a climatic region or of a habitat. But the present observations do not fully confirm such a hypothesis. Some species, namely, *Aeolesthes* (*s. str.*) *holosericea*, *Plocaederus obesus*, *Acalolepta rusticator*, *Olenecamptus bilobus*, etc., usually take more than a year to complete their life-cycle in the mainland of India.

However, these borers in the insular environment of the Andamans, complete 2-4 generations per year. It can be inferred that the non-seasonal climate prevailing in these islands situated nearer the Equator, favours a shorter life-cycle through frequent mating and ovipositing activities. In contrast, the predominating seasonal climate on the mainland of India favours a longer life-cycle. Moreover, the characteristic depauparate nature of the borer-fauna in the insular areas, perhaps reduces both the inter- and intra-specific competition for the same wood-hosts, which may increase the reproductive potentiality of these borers.

Imaginal life :

Sexual activities are the most important aspects of imaginal life of the cerambycid-beetles. The duration of the active imaginal life varies from species to species, as well as, from individual to individual of the same species. With a good supply of food, as observed in the laboratory, *Halme caerulescens* survives about 11 days, while *Batocera rufomaculata* var. *andamana* for about six months. Without food, the

duration of the imaginal life is greatly reduced as observed from the laboratory experiment on *Batocera rufomaculata* var. *andamana*. Without food, adults of this species only survive 33 days, whilst with food they survive on an average of 115 days. However, food is also required for the attainment of sexual maturity (Duffy, 1953). In most lamiine-beetles mating does not occur prior to the ingestion of sufficient quantity of food. This is true for almost all the lamiine-species concerned with the present study. However, it does not hold good for the prionine and cerambycine-borers, where the copulation commences immediately after the emergence of adult-beetles, and oviposition follows 4-5 days thereafter. It indicates, therefore, that feeding is essential not only for the survival, but also for the attainment of the sexual maturity, at least for some cerambycid-borers.

As indicated earlier, the adults depend on a wide range of host-species. In addition, they show a clear preference for feeding on particular parts of the hosts, such as, tender and older bark, green twigs, fresh leaves, flowers, even pollen grains, etc. The effect of the quality of the food on different borers is difficult to ascertain at present, yet the consequence of feeding on the pollen grains by some species is interesting and worth mentioning. The mean potential fecundity of *Aeolesthes* (s. *str.*) *holosericea*, one of the most important pollen feeding species recognised so far from these islands, has been estimated highest of all the species inhabiting the Andamans. The females of this species have the capability of laying an average of 500 eggs (realised fecundity was 394 and the number of unlaid mature eggs at the time of death was 106) during their life-span of only 30 days. The protein rich diet of the pollen grains probably increases the fecundity of this species, though some other unknown factors may be involved.

Borer-community in the logs :

The interaction within the insect-community associated with the felled logs is one of the most interesting ecological problems to deal with. However, the cerambycid-community associated with the different logs or timbers studied in the islands of Andaman is neither very rich nor attains a climax community as such. In any community, certain factors can easily be identified which determine the number of species assembled (Price, 1975). The first and most important factor is the period of time taken by the community for colonization. Since, the present study is based mainly on the timbers of commercial importance which are rarely left in the timber extraction and logging centres for a long enough period for a climax community to develop. Two other external factors, such as, the species pool of the colonizers, as well as, the distance of the

new infestation target from the source of the colonizers, are of considerable importance. Among the third set of factors, the hospitability of the host-material to the colonizers is of prime importance. It is well known that such hospitability depends primarily upon the condition of the host-material in respect of its progressive drying, which, in turn, depends upon the temperature, humidity and many other physico-chemical factors of its surrounding environment ; (Khan and Maiti, 1982a ; Maiti, *et al.*, 1983). These are actually what have been indicated by the logs lying in the timber extraction and logging centres inside the forest areas. These logs with the previlege of their location near the cerambycid-colonizers inside the forests, as well as, with the influence of their surrounding environment with low temperature and high humidity maintain their conditions suitable for cerambycid attack for a longer period. As a consequence, they usually support more numbers of species in higher intensity than the logs situated in the non-forested areas for an equal length of time.

However, the cerambycid-borers have been found to be the most successful invaders of the felled logs of different ages, probably owing to the fact that they are the most dominant immigrants amongst all other insects invading most of the tropical insular land masses of the world.

X. CONCLUDING REMARKS

It will be a pretencious claim to treat this paper as a complete bioecological contribution on the cerambycid-borers of the islands of Andaman. Even though numerous biological data on these borers have been incorporated, many important problems are left unresolved and few species have not been considered at all.

The biotaxonomic key based on the characteristic features of the larval galleries and pupal chambers seems to be very sound, but the range of variation of such characters which are modified under certain abnormal conditions, remains to be included in future.

The biological data incorporated in the present account, will undoubtedly enhance our knowledge of the life processes of these borers, but many gaps remain to be filled in through future research. The survival potentiality of these insects is greatly dependent on some vital aspects of the host-specificity and host-selection, food requirements, reproductive strategy, etc. The life-history of the cerambycid-borers has two well defined phases, namely, the larval feeding phase inside the

wood and the imaginal reproductive phase outside the wood-habitat. These two stages are so different, not only in their structural details, but also, in their food-requirements that the internal competition between the parent and offspring, both for food and shelter, becomes climinated. If the situation demands, the same individual larva is also able to exploit the different nutritional zones in the same wood for shelter and proper growth. Further, the pupal stage, interconnecting the larval and imaginal life, is greater resistance to the adverse conditions and is capable of regulating the emergence of adults in the optimum environmental conditions for the survival and successful propagation of their populations. Thus, the detailed study of their biological peculiarities, centred around the survival potentiality of these borers, is certainly a profitable line of research to be taken in the future.

Further, some of these borers, like other insects, attack most of the host-plants available, whereas the others confine themselves to a few or one of them only. Under almost identical ecological, phenological and physiographical conditions, the differences of infestation of the plants by different borers are usually determined by the interaction of the different responses of the insects to the plants and by the various characteristics of the plants concerned. This is a wide area requiring further detailed studies.

Likewise, there is ample scope of investigating the ecological factors responsible for the sound survival potentiality of these noxious insects. The specific nature of both inter- and intra-specific competition, the unique adjustment with micro- and macro-climatic factors of the environment, adaptability to the physico-chemical changes with the progressive age of the hosts, etc., are some of the interesting problems to be investigated, if the strategy of their management is to be determined. Unfortunately, in India, the instruments for measuring the microclimatic factors, such as, temperature, humidity, wind pressure, etc., within the enclosed space of the wood-habitats are hardly available.

However, the present endeavour is certainly a humble beginning to these vital enquiries of the life processes of the cerambycid-borers. The bioecological data, the intelligent manipulation of such, may provide some clue to the management of the borer's populations to save our valuable wood in human services in the Indian subcontinent. However, the present account certainly satisfies the primary enquiries of the general bioecology of the borers of economic importance on one hand and provides further guide lines for the future research on the other.

XI. SUMMARY

The monograph deals with some aspects of the biotaxonomy, biology and ecology of some 30 species of cerambycid-borers based on investigations during the last three years in the islands of Andaman. The work was done under a research project on "The ecological interaction and economic status of the xylophagous insects of the islands of Andaman and Nicobar", carried out at the Zoological Survey of India, Calcutta, as well as, at the Andaman and Nicobar Regional Station, Z. S. I., Port Blair.

As regards the biotaxonomic studies, the characteristic features of shape, size and orientation of the larval galleries and pupal chambers of some 30 species have been utilized to formulate a key for the recognition of the individual species in the field itself. After the emergence of adults from the infested host materials, the examination of the larval galleries and pupal chambers of each species usually gives some clue to the identity of the species infesting the wood.

The general biology of all the species, based on field and laboratory observations, has been incorporated with particular reference to their larval and imaginal development, pattern of galleries and pupal chambers, entrance- and exit-holes, feeding and sexual behaviour, duration of larval and imaginal life, etc. In addition, the hosts and damage propensities of all the borers have specially been treated and relative economic importance has been ascertained.

Most of the cerambycid-beetles, studied, prefer freshly felled logs for oviposition and nearly 80% of the species occur in the felled logs of two months old, after which the infestation declines rapidly. The logs of *Canarium euphyllum* and *Pterocymbium tinctorium* remain susceptible to attack by a number species for a longer period of 1-7 months. The reason may be the characteristic nature of soft wood and the thick bark of these hosts retaining the moisture for longer span of time. The species, *Stromatium barbatum*, has the unique capability of ovipositing in excessively dry wood, probably due to its ability to retain body moisture in the dry micro-climatic conditions.

All the cerambycid borers inhabiting the islands of Andaman may commonly be referred to as 'secondary pests', since they are hardly capable of either killing the live host-plants or totally destroying the infested wood. The majority of the species obviously infest the felled logs and stored timbers, while only eight species infest live unhealthy trees. *Rhaphipodus* (*s. str.*) *andamanicus* and *R.* (*Remphan*) *hopei* appear

to be the most destructive in the timber extraction centres and timber depots, *Stromatium barbatum* in dry and seasoned wood and *Aeolesthes* (*s. str.*) *holosericea* in standing unhealthy trees in the forest stands. *S. barbatum* is the most polyphagous species, while *Halme caerulescens* and *Glenea* (*Stiroglenea*) *andamanica* are monophagous. The lamiine species usually have a narrower host-range as compared with the cerambycine beetles. The logs of *Salmalia insignis* and *Canarium euphyllum* seem to be most susceptible to cerambycid attack, while *Terminalia bialata* is the least susceptible.

The population density of the borers in different host-logs is not so high as one could expect in the tropical insular environment of the Andamans. The average number of larvae per unit-area of 25 sq. cm is not more than four, whatever may be the host condition and situation. However, some species, namely, *Plocaederus obesus*, *Acalolepta rusticator*, *Batocera rufomaculata* var. *andamana* and *Olenecamptus bilobus* maintain a high population density in the logs of *Artocarpus chaplasha* and *Pterocymbium tinctorium*. On the other hand, *Aeolesthes* (*s. str.*) *holosericea* and *Acalolepta andamanica* stand in the second rank as far as the population density is concerned in the logs of *Terminalia procera*. The larval population density of a single borer also varies within certain limits depending upon the condition of the different host-plants.

Equal economic importance cannot be attached to the cerambycid-borers studied, since their destructive propensities vary from species to species and from host to host. The majority of the species spend their entire larval life under the bark, where there is least possibility of causing significant damage to the valued wood. In contrast, only a few species, namely, *Rhaphipodus* (*s. str.*) *andamanicus*, *R.* (*Remphan*) *hopei*, *Stromatium barbatum*, *Plocaederus obesus*, *Aeolesthes* (*s. str.*) *holosericea* and *Batocera rufomaculata* var. *andamana*, are of considerable economic importance, since their larvae excavate enormous tunnels which extend deep inside the wood, greatly reducing its commercial value. The extent of damage by any wood-boring beetle greatly depends upon the duration of larval life, which, in turn, is influenced by the quality of the food. The larvae feeding on the inner-bark or on the fresh sapwood take a shorter period to complete their development in comparison to those feeding on the heart-wood. Direct damage by the deep-boring cerambycid-larvae reaches a maximum during the period from three to eight months after the initial attack in the extracted and stored timbers of these islands.

Lastly, a general discussion has been taken into account on the important bioecological criteria of the different borers. The biological

peculiarities of the borer species has been explained as far as possible in the light of the existing knowledge available from the recent literature.

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CATALOGUE OF HOST PLANTS OF ANDAMANESE CERAMBYCIDAE

Acacia pennata Willd.	*Stromatium barbatum*
Aegle marmelos (Linn.) Correa	*Stromatium barbatum*, *Aeolesthes* (*s.str.*) *holosericea*, *Pterolophia* (*s.str.*) *sterculiae*, *Acalolepta rusticator*
Albizzia chinensis (Osb.) Merr.	*Xystrocera globosa*, *Stromatium barbatum*
Albizzia lebbek Benth.	*Xystrocera globosa*, *Pterolophia* (*s. str.*) *andamanica*
Albizzia lucida Benth.	*Pterolophia* (*s.tr.*) *andamanica*
Albizzia procera Benth.	*Xystrocera globosa*, *Stromatium barbatum*
Anacardium occidentale Linn.	*Acalolepta andamanica*
Artocarpus chaplasha Roxb.	*Plocaederus obesus*, *Epepeotes* sp., *Acalolepta andamanica*, *A. rusticator*, *Batocera rufomaculata* var. *andamana*, *Olenecamptus bilobus*
Artocarpus integrifolia Linn.	*Acalolepta rusticator*, *Olenecamptus bilobus*
Artocarpus lakoocha Roxb.	*Stromatium barbatum*, *Ceresium andamanicum*, *C. geniculatum*
Bauhinia Sp.	*Xystrocera globosa*, *Stromatium barbatum*
Bambusa sp.	*Stromatium barbatum*
Briedelia tomentosa Bl.	*Stromatium barbatum*
Canarium euphyllum Kurz	*Plocaederus obesus*, *Clyzomedus annularis*, *Coptops rufa*, *Pharsalia* (*Cycos*) *subgemmata*, *Epepeotes* sp., *Acalolepta andamanica*, *A. rusticator*, *Batocera rufomaculata* var. *andamana*, *Olenecamptus bilobus*
Carallia brachiata (Lour.) Merr.	*Stromatium barbatum*

Carapa moluccensis A. Juss. . .	*Stromatium barbatum*
Cassia fistula Linn. . . .	*Stromatium barbatum, Xylotrechus buqueti, Desisa (Cylindrostyrax) marmorata , Mispila (s.str.) venosa* m. *augularis*
C. nodosa Ham. . .	*Stromatium barbatum*
C. siamea Lam. Vern. .	*Stromatium barbatum*
Casuarina equisetifolia (Linn.) Forst .	*Stromatium barbatum, Ceresium flavipes*
Citrus aurantium Linn. .	*Stromatium barbatum*
C. maxima (Burm.) Merr. . .	*Stromatium barbatum, Acalolepta rusticator*
C. medica Linn. . . .	*Stromatium barbatum*
Cynometra ramiflora Linn. . .	*Aeolesthes (s.str.) holosericea*
Dalbergia volubilis Roxb. . .	*Stromatium barbatum*
Dipterocarpus spp. . .	*Rhaphipodus (Remphan) hopei, Stromatium barbatum, Xylotrechus buqueti ,Batocera rufomaculata* var. *andamana.*
Dracontomelum mangiferum Bl.	*Aeolesthes (s.str.) holosericea*
Duabanga sonneratioides . . Buch.-Ham.	*Aeolesthes (s.str.) holosericea, Xylotrechus buqueti, Pterolophia (s.str.)andamanica*
Erythrina variegata Linn. .	*Acalolepta rusticator*
Excoecaria agallocha Linn.	*Stromatium barbatum*
Ficus bengalensis Linn.	*Batocera rufomaculata* var. *andamana, Olenecamptus bilobus*
F. carica Linn.	*Stromatium barbatum, Ceresium andamanicum, Olenecamptus bilobus, Xenolea tomentosa*
F. gomeziana Wall.	*Ceresium andamanicum*
F. hispida Linn. f.	*Stromatium barbatum*
F. infectoria Roxb.	*Olenecamptus bilobus*

F. religiosa Linn.	*Pterolophia (s. str.) sterculiae, Epepeotes* sp., *Acalolepta rusticator, Olenecamptus bilobus, Xenolea tomentosa*
F. retusa Linn.	*Stromatium barbatum*
F. rumphi Blume . .	*Stromatium barbatum*
Other **Ficus** species ..	*Clyzomedus annularis, Coptops rufa, Ropica honesta* m. *rufescens, Pterolophia (s.str.) andamanica, Mispila (s. str.) venosa* m. *augularis, Acalolepta rusticator, Batocera rufomaculata* var. *andamana*
Garuga pinnata Roxb. .	*Stromatium barbatum, Plocaederus obesus, Pharsalia (Cycos) subgemmata*
Instsia bijuga (Colebr.) Ktze.	*Acalolepta rusticator*
Lannea coromandelica (Houtt.) Merr.	*Stromatium barbatum, Aeolesthes (s. str.) holosericea, Plocaederus obesus, Ropica honesta* m. *rufescens, Xenolea tomentosa*
Lagerstroemia hypoleuca Kurz .	*Ceresium geniculatum*
Lagerstroemia sp.	*Xylotrechus buqueti*
Mallotus philippinensis Mull. Arg.	*Stromatium barbatum*
Mangifera andamanica King	*Stromatium barbatum, Aeolesthes (s. str.) holosericea, Plocaederus obesus, Pharsalia (Cycos) subgemmata, Olenecamptus bilobus.*
Mangifera indica Linn.	*Stromatium barbatum, Aeolesthes (s. str.) holosericea, Plocaederus obesus, Clyzomedus annularis, Pharsalia (Cycos) subgemmata, Epepeotes* sp., *Batocera rufomaculata* var. *andamana, Olenecamptus bilobus*
Mangifera sylvatica Roxb. .	*Clyzomedus annularis, Pharsalia (Cycos) subgemmata*
Mimusops littoralis Kurz ..	*Pterolophia (s. str.) andamanica, P. (s. str.) pallidifrons*

Murraya exotica Linn.	*Stromatium barbatum*
Murraya paniculata (Linn.) Jack.	*Stromatium barbatum*
Myristica andamanica Hook .	*Serixia* (*s. str.*) *andamanica*
Myristica longifolia Wall. . .	*Xylotrechus buqueti*
Myristica sp. . ..	*Epepeotes* sp.
Parishia insignis Hook . .	*Rhaphipodus* (*s.str.*) *andamanicus*, *Batocera rufomaculata* var. *andamana*
Planchonia andamanica King ..	*Ceresium andamanicum*
Pongamia pinnata (Linn.) Merr. .	*Stromatium barbatum*, *Ropica honesta* m. *rufescens*
Prunnus martabanica Kurz	*Aeolesthes* (*s. str.*) *holosericea*
Pterocarpus dalbergioides Roxb.	*Xylotrechus buqueti*, *Desisa* (*Cylindrostyrax*) *marmorata*, *Acalolepta admixta*, *Xenolea tomentosa*,
Pterocymbium tinctorium Merr. ..	*Rhaphipodus* (*s. str.*) *andamanicus*, *Plocaederus obesus*, *Coptops rufa*, *Acalolepta andamanica*, *A. rusticator*, *Batocera rufomaculata* var. *andamana*, *Olenecamptus bilobus*, *Glenea* (*Stiroglenea*) *andamanica*
Pterospermum acerifolium Willd.	*Acalolepta admixta*
Pterygota alata (Roxb.) R. Br.	*Stromatium barbatum*, *Plocaederus obesus*, *Pterolophia* (*s. str.*) *pallidi frons*, *P.* (*s. str.*) *sterculiae*, *Mispila* (*s. str.*) *venosa* m. *augularis*
Rhizophora apiculata Bl. .	*Aeolesthes* (*s. str.*) *holosericea*, *Ceresium flavipes*
Rhizophora candelaria DC	*Aeolesthes* (*s. str.*) *holosericea*
Salmalia insignis .. . .. Scott & Endl.	*Rhaphipodus* (*s. str.*) *andamanicus*, *Aeolesthes* (*s. str.*) *holosericea*, *Plocaederus obesus*, *Acalolepta andamanica*, *A. rusticator*, *Batocera rufomaculata* var. *andamana*, *Olenecamptus bilobus*

Salmalia malabarica (Decand.) Scott & Endl.	*Rhaphipodus* (*s. str.*) *andamanicus*, *Xystrocera globosa*, *Aeloesthes* (*s. str.*) *holosericea*, *Plocaederus obesus*, *Ropica honesta* m. *rufescens*, *Olenecamptus bilobus*
Samanea saman (Jacq.) Merr.	*Xystrocera globosa*, *Coptops rufa*, *Ropica honesta* m. *rufescens*, *Pterolophia* (*s. str.*) *andamanica*, *P.* (*s. str.*) *pallidifrons*, *Acalolepta rusticator*, *Exocentrus* (*Camptomyme alboscutellaris*
Semecarpus kurzii Engl.	*Clyzomedus annularis*, *Epepeotes* sp., *Acalolepta andamanica*, *A. rusticator*, *Batocera rufomaculata* var. *andamana*
Spondias pinnata (Linn.f.) Kurz	*Plocaederus obesus*, *Pharsalia* (*Cycos*) *subgemmata*
Sterculia colorata Roxb.	*Plocaederus obesus*
Sterculia villosa Roxb.	*Plocaederus obesus*
Teminalia bellirica Roxb.	*Stromatium barbatum*, *Aeolesthes* (*s. str.*) *holosericea*
Terminalia bialata Steud.	*Stromatium barbatum*, *Serixia* (*s. str.*) *andamanica*
Terminalia manii King	*Ceresium geniculatum*, *Halme caerulescens*
Terminalia procera Roxb.	*Aeloesthes* (*s. str.*) *holosericea*, *Acalolepta andamanica*
Tectona grandis Linn.	*Aeolesthes* (*s. str.*) *holosericea*, *Xylotrechus buqueti*, *Desisa* (*Cylindrostyrax*) *marmorata*, *Acalolepta rusticator*, *Xenolea tomentosa*, *Exocentrus* (*Camptomyme*) *alboscutellaris*
Tetrameles nudiflora R. Br.	*Plocaederus obesus*
Xylocarpus granatum Koen	*Stromatium barbatum*

Index

The names in italics concern synonyms. Page numbers printed first and in bold face refer to the biotaxonomic key and biological description respectively.

ERRATA

Page No.	Line	Printed	To be read
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2	37	latitudes	latitude
4	34	centrers	centres
14	15—16	Kalimastan	Kalimantan
15	Title	KHAIN	KHAN
17	35	The vigorous trees	Less vigorous trees
22	15	Becson and Bhatia	Beeson and Bhatia
22	16	has bren	has been
22	19	*Sterculia alata*	*Pterygota alata*
23	30	*Salmalia malabɹria*	*Salmalia malabarica*
31	16	—3 hours	2—3 hours
32	3	(Pasoe).	(Pascoe),
33	13	are sealed	is sealed
36	27	resionous	resinous
38	7	developmenal	developmental
39	30	*Sterculia alata*	*Pterygota alata*
41	4	*Sterculia alata*	*pterygota alata*
43	25	*Sterculia alata*	*Pterygota alata*
50	11	aolmost	almost
50	12	mhsoon	monsoon
50	14	nocturna	nocturnal
50	27	*Lamila*	*Lamia*
51	19	*tinctortum*	*tinctorium*
52	21	*Andamana*	*andamana*
53	4	cellected	collected
53	8	*salmaɭia*	*Salmalia*
54	20	*Olenecampus*	*Olenecamptus*
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62	21	*Epepeotes,*	*Epepeotes sp.,*
62	21	*Acalolepta, rusticator*	*Acaloiepta rusticator,*
65	4	*A. rutieator*	*A. rusticator*
77	5	1981a	1981
77	36	them	these

PLATES

PLATE I

A. *Rhaphipodus* (*s.str.*) *andamanicus* Gahan. Larval mines in the heart-wood of a large log of *Parishia insignis*.

B-D. *Rhaphipodus* (*Remphan*) *hopei* (Waterhouse) ;

B. Longitudinal section through the heart-wood of a large log of *Dipterocarpus* sp., showing the larval mines.

C. Extensive galleries, packed with coarse fibrous frass, of a single larva deep inside the wood of *Dipterocarpus* sp.

D. A dead standing tree of *Dipterocarpus* sp., showing the exit-holes made on the wood-surface by the emerging adult beetles.

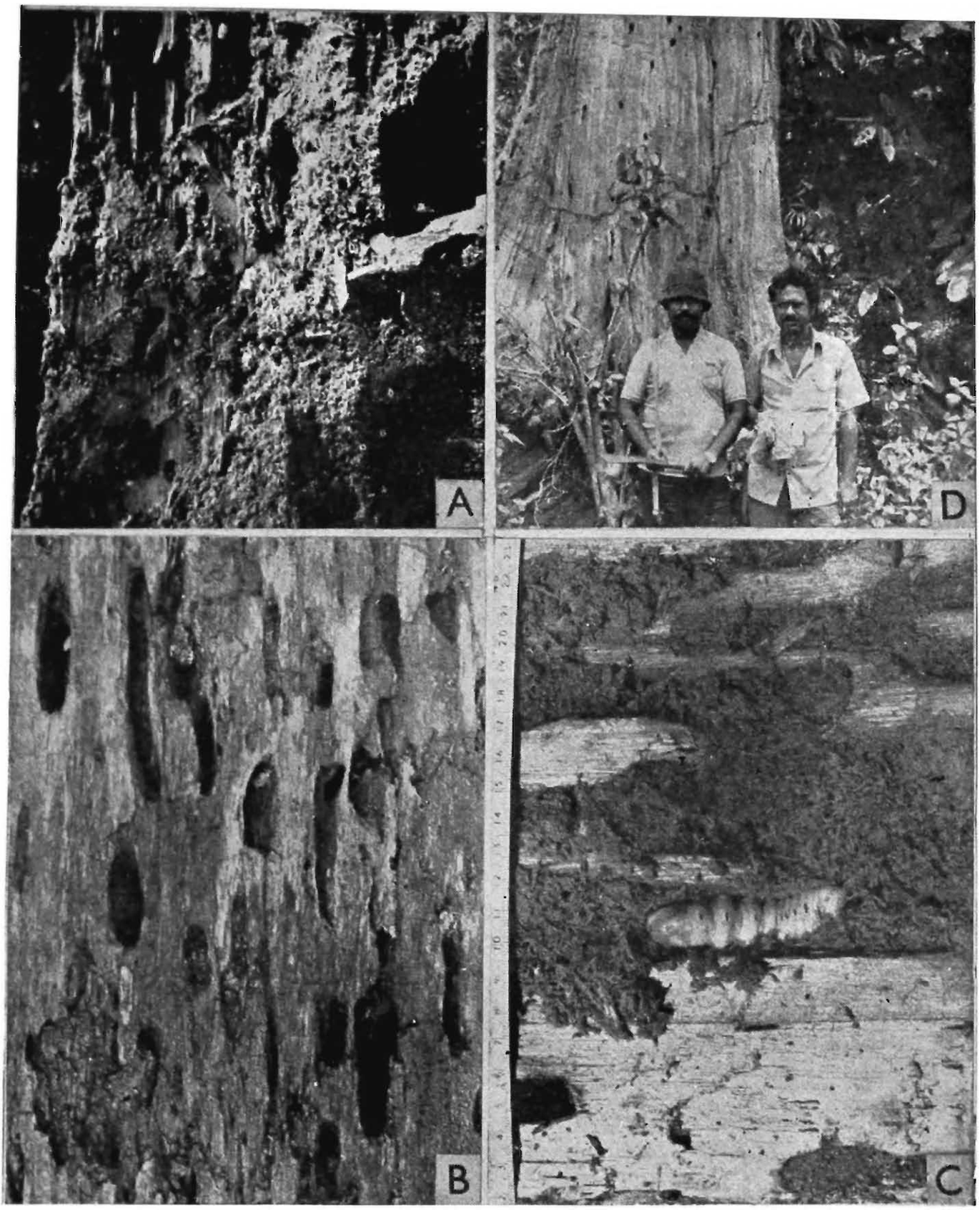
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PLATE II

A-D. *Xystrocera globosa* (Olivier) ;

A. Galleries and entrance-hole made by a larva on the wood-surface of a log of *Samanea saman* (a mixture of fibrous and granular frass visible inside the larval galleries.

B. A portion of a dead standing tree of *Samanea saman,* showing the entrance-cum exit-holes.

C. Longitudinal section through the superficial layer of heart-wood of *Samanea saman,* showing the pupae *in situ* inside the pupal chambers.

D. Pupal chamber with pupa *in situ* inside the sap-wood of *Samanea saman,* showing also a portion of the thin walled cocoon in the shape of a capsule.

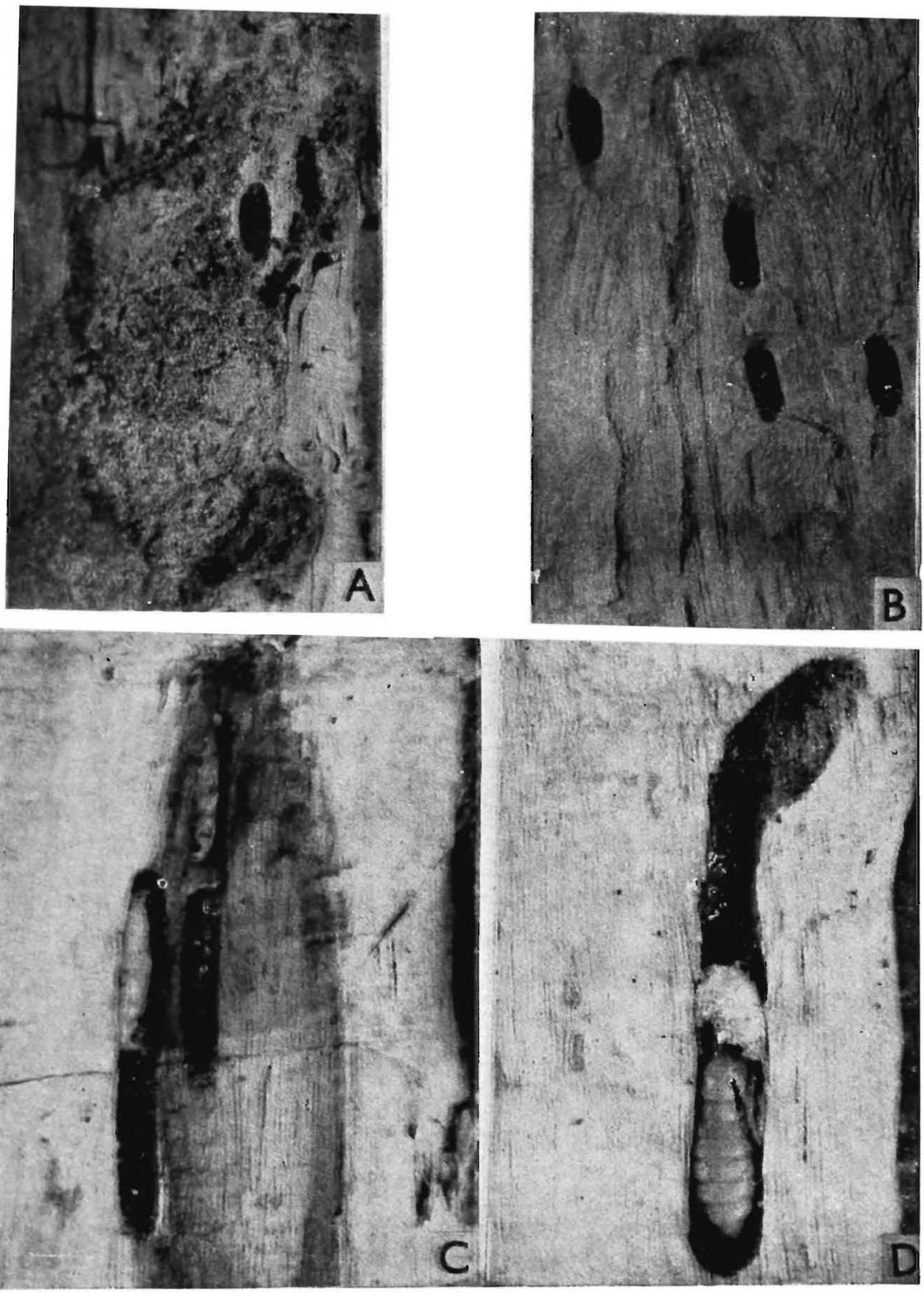
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PLATE III

A. *Aeolesthes* (*s.str*) *holosericea* (Fabricius). Pupal chamber with pupa *in situ* inside a log of *Salmalia malabarica*. The calcareous operculum noticeable on the upper end closing the opening.

B and C. *Plocaederus obesus* Gahan ;

B. Larval mine and pupal chamber inside the heart-wood of *Tetrameles nudiflora*, wherein the egg-shaped, thick walled calcareous cocoon placed in the middle of the pupal chamber.

C. Enlarged view of a calcareous cocoon, exposed at one end to show the pupa *in situ* and thickness of the wall.

D. *Ceresium geniculatum* White. The characteristic 'L'-shaped pupal chamber inside the sap-wood of *Artocarpus lakoocha*, with the fibrous plug sealing the opening.

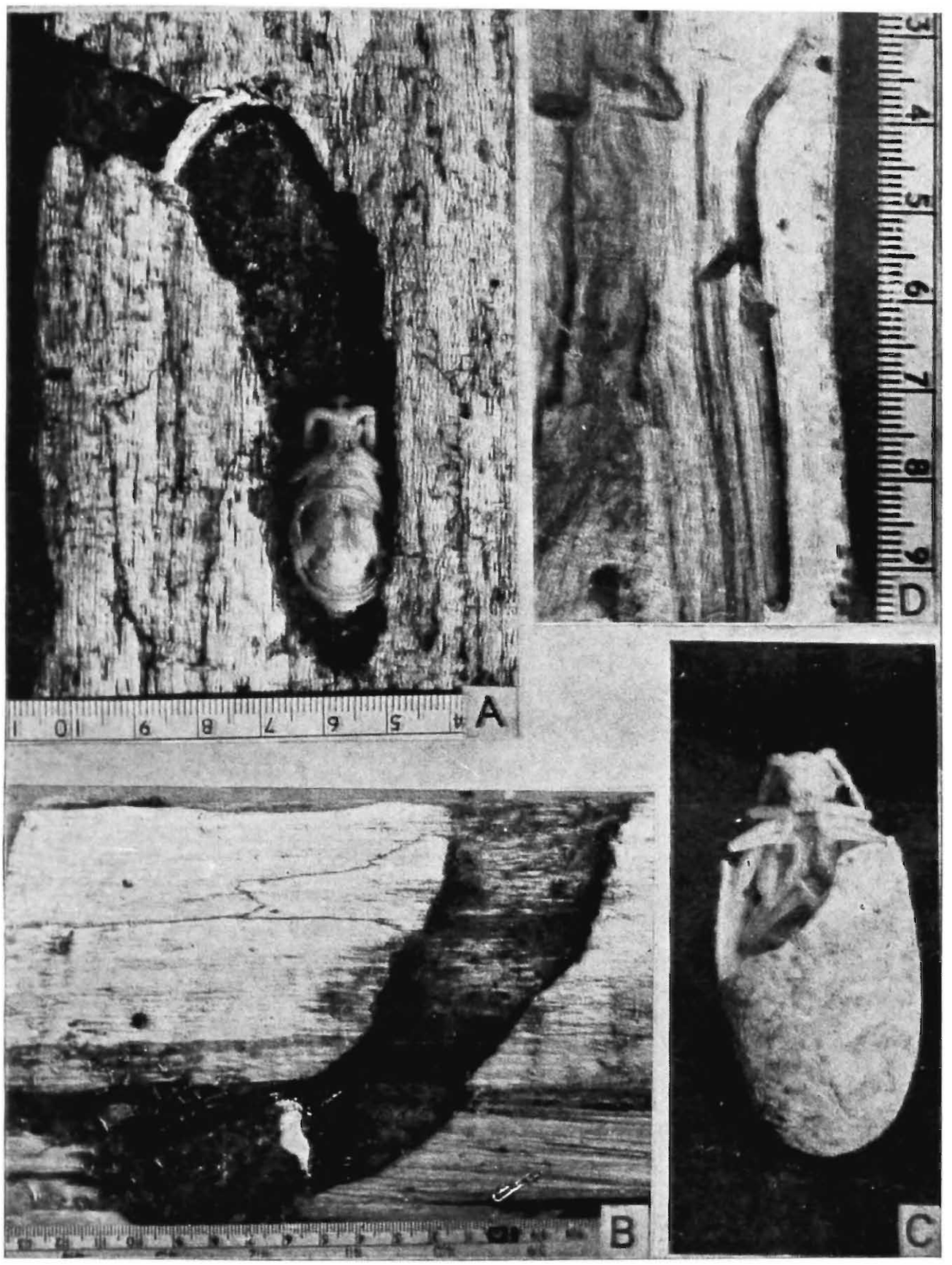
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PLATE IV

A. *Ceresium geniculatum* White. A dormant adult inside the pupal chamber in a log of *Artocarpus lakoocha,* wherein the extra larval mine visible in front of the beetle directed towards the right.

B and C. *Ceresium flavipes* (Fabricius) ;

B. Larval galleries and entrance-hole on the wood-surface of a felled log of *Casuarina equisetifolia.*

C. The characteristic 'T'-shaped pupal chamber inside the sap-wood of a felled log of *Casuarina equisetifolia.* The fibrous plug visible behind the extra larval mine concealing the opening of the pupal chamber.

D. *Ceresium andamanicum* Gahan. Larval galleries, packed with a fine powdery frass and the entrance-hole on the wood-surface of *Artocarpus lakoocha,* after removal of the bark.

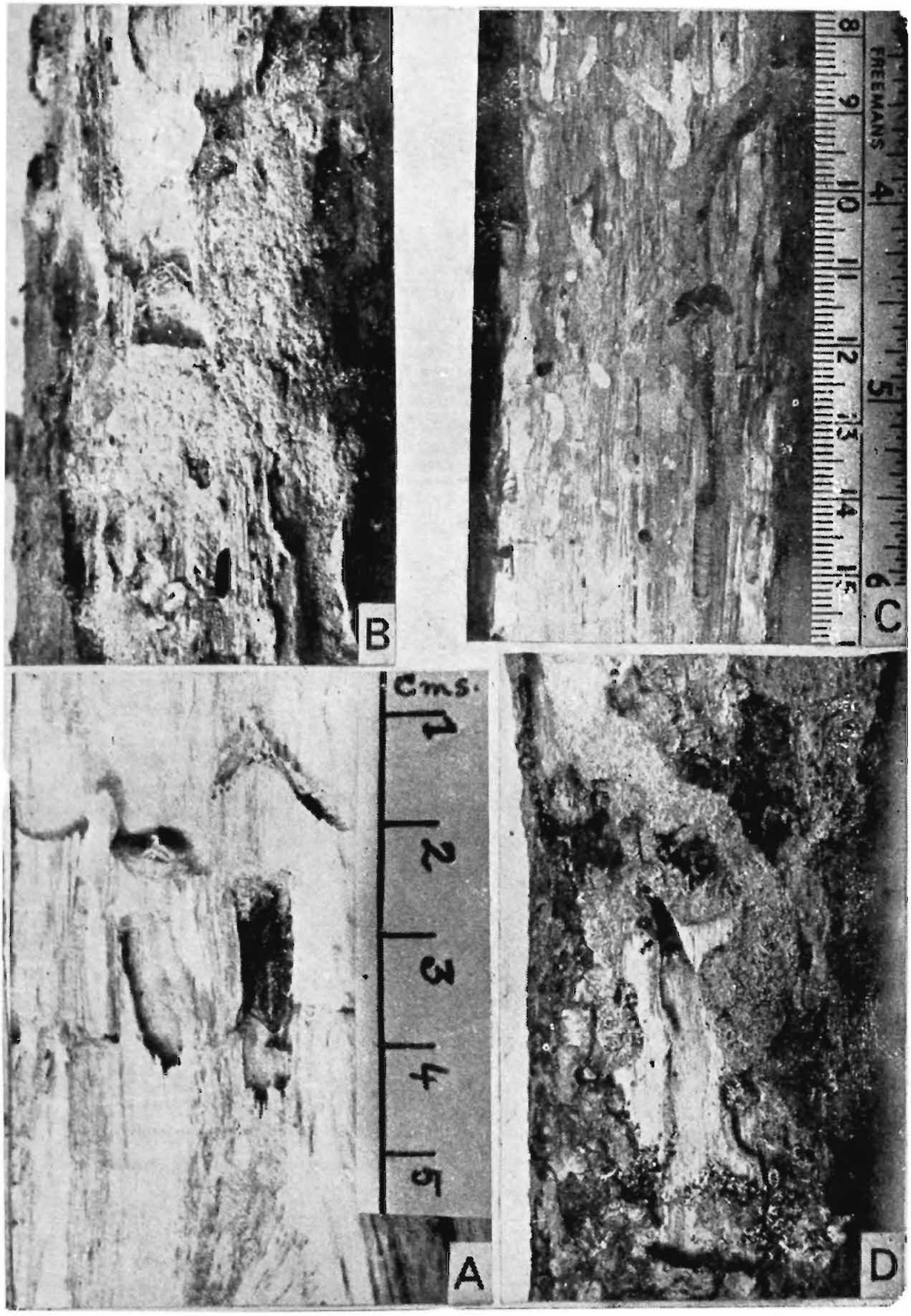
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PLATE V

A. *Xylotrechus buqueti* (Lap. and Gory). Longitudinal section through a log of *Duabanga sonneratioides,* showing the larval galleries, pupal chamber and exit-hole.

B-D. *Halme caerulescens* Gahan ;

B. Inner surface of the bark of *Terminalia manii,* showing the larval galleries packed with fine powdery frass, a larva *in situ* on right and a pupa of a trogostid beetle on the left.

C. Transverse section through a small log of *Terminalia manii,* showing the characteristic vertical pupal chamber inside the superficial layers of the wood.

D. Surface of a log of *Terminalia manii,* showing the exit-holes made on the bark surface by the emerging adult beetls.

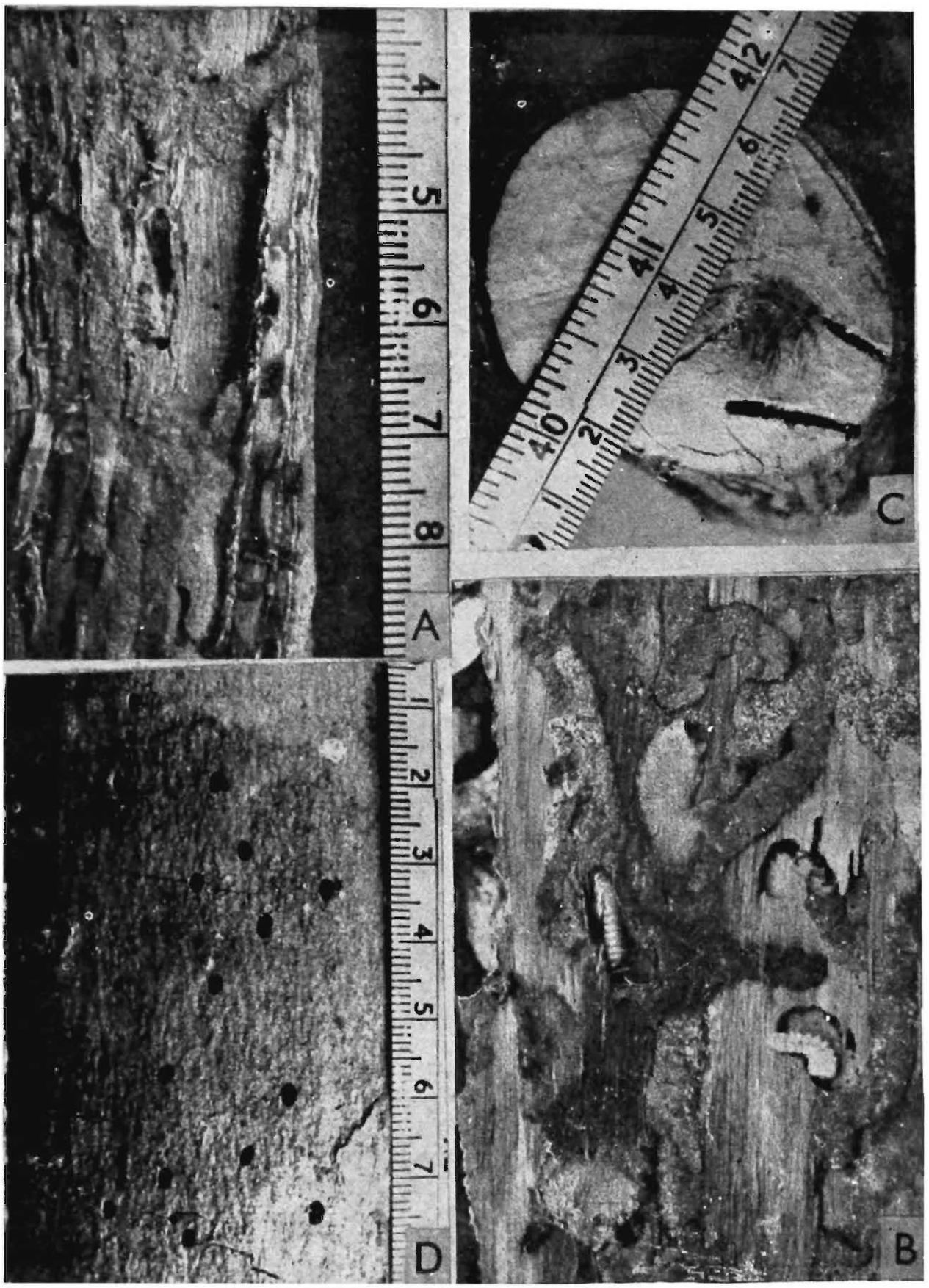
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Plate VI

A. *Clyzomedus annularis* Pascoe. Pupa *in situ* inside the pupal chamber, encircled by a thin wall of wood-fibres, within superficial engravement on the wood-surface under the bark of *Samanea saman.*

B. *Coptops rufa* Thomson. A pupa *in situ* inside the pupal chamber just on the wood-surface below the bark of *Samanea saman.*

C. *Ropica honesta* m. *rufescens* Pic. Inner surface of the bark of a log of *Samanea saman,* showing the larval gallery and pupal chamber.

D. *Pterolophia* (*s.str.*) *andamanica* Breuning. The characteristic "bird's nest" like pupal chamber just on the wood-surface under the bark of a dead small branch of *Mimusops littoralis.*

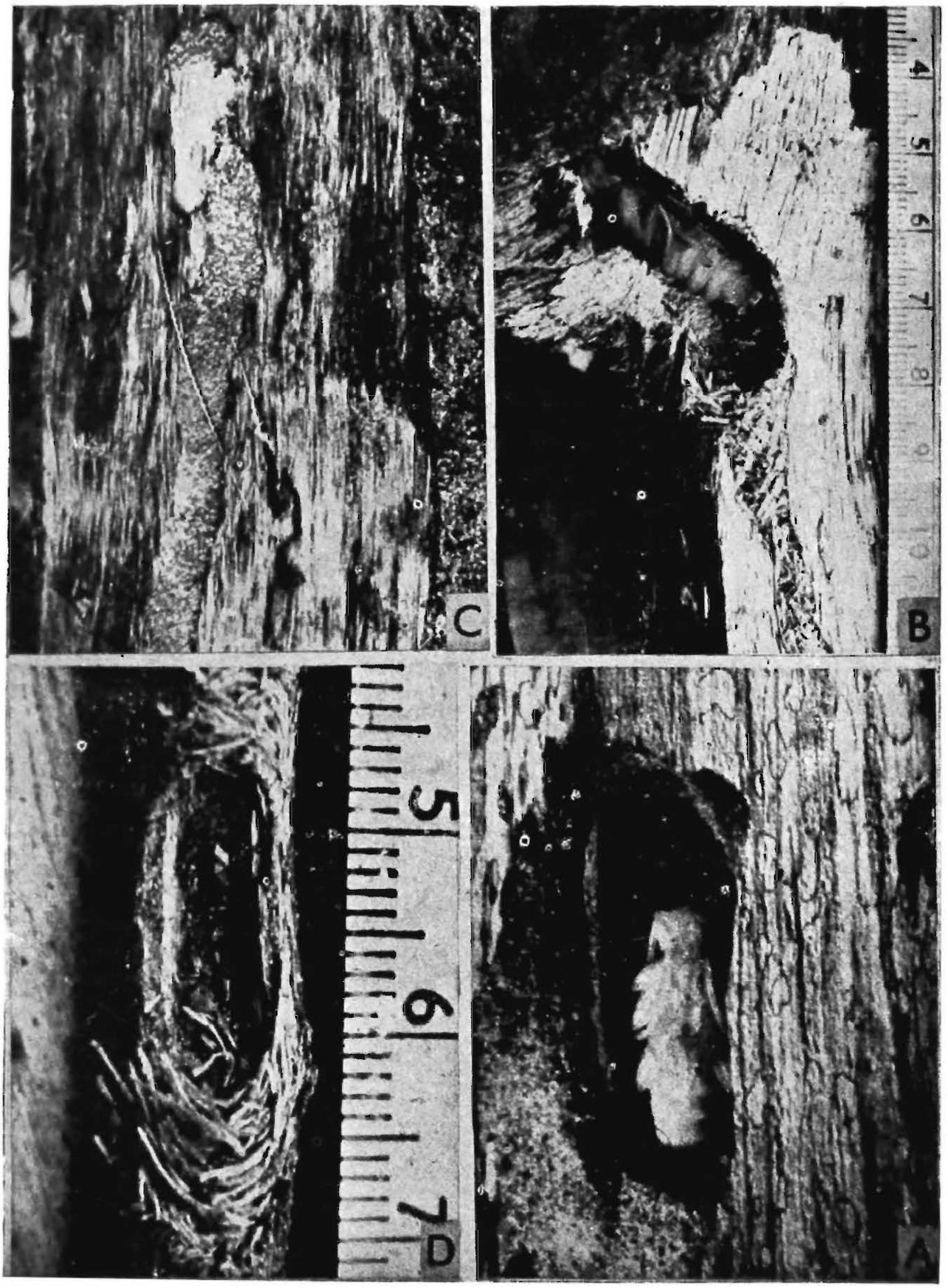
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PLATE VII

A. *Pterolophia* (*s.str.*) *pallidifrons* Breuning. The pupal chamber with dormant adult *in situ* inside the engravement on the wood-surface below the bark of *Samanea saman.*

B and C. *Pterolophia* (*s.str.*) *sterculiae* Breuning ;

B. The egg-pit inside a freshly cut small branch of *Ficus religiosa* showing an egg *in situ.* Arrow indicating the opening of the egg-pit.

C. The typical "bird's nest" like pupal chamber on the wood-surface, just under the bark of *Sterculia alata.*

D. *Desisa* (*cylindrostyrax*) *marmorata* Breuning. Surface of a small branch of *Pterocarpus dalbergioides,* showing the opening of the egg-pits on the bark surface.

E. *Pharsalia* (*Cycos*) *subgemmata* (Thomson). Longitudinal section through a log of *Mangifera indica,* showing the pupal chamber with pupa *in situ* inside the sap-wood.

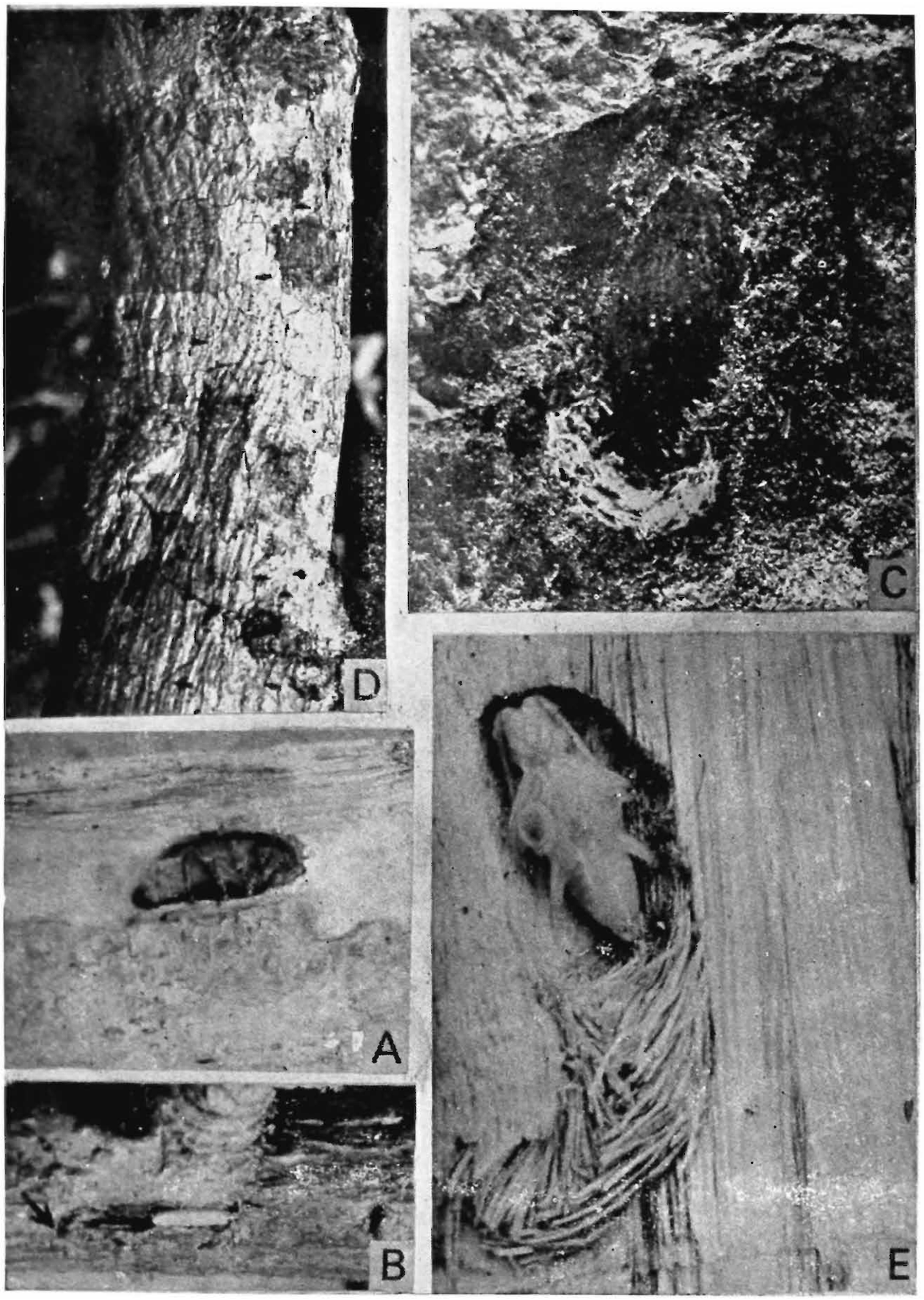
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PLATE VIII

A and B. *Epepeotes* sp.

A. Egg *in situ* inside the egg-pit in the bark of a small branch of *Ficus religiosa* Arrow indicating the opening of the egg-pit.

B. Longitudinal section through a log of *Artocarpus chaplasha*, showing the pupal chamber inside the sap-wood, wherein the exit-hole commencing slightly before the distal end of the chamber.

C-E. *Acalolepta andamanica* (Breuning) ;

C. Opening of a typical egg-pit on the bark-surface of a freshly felled log of *Anacardium occidentale*.

D. Egg inside the egg-pit within the bark of a freshly felled log of *Anacardium occidentale*, arrow indicating the egg-pit opening.

E. Longitudinal section through a log of *Canarium euphyllum*, showing the pupal chamber inside the sap-wood.

F. *Acalolepta rusticator* (*Fabricius*). Longitudinal section through a log of *Artocarpus integrifolia*, showing the pupal chamber inside the sap-wood.

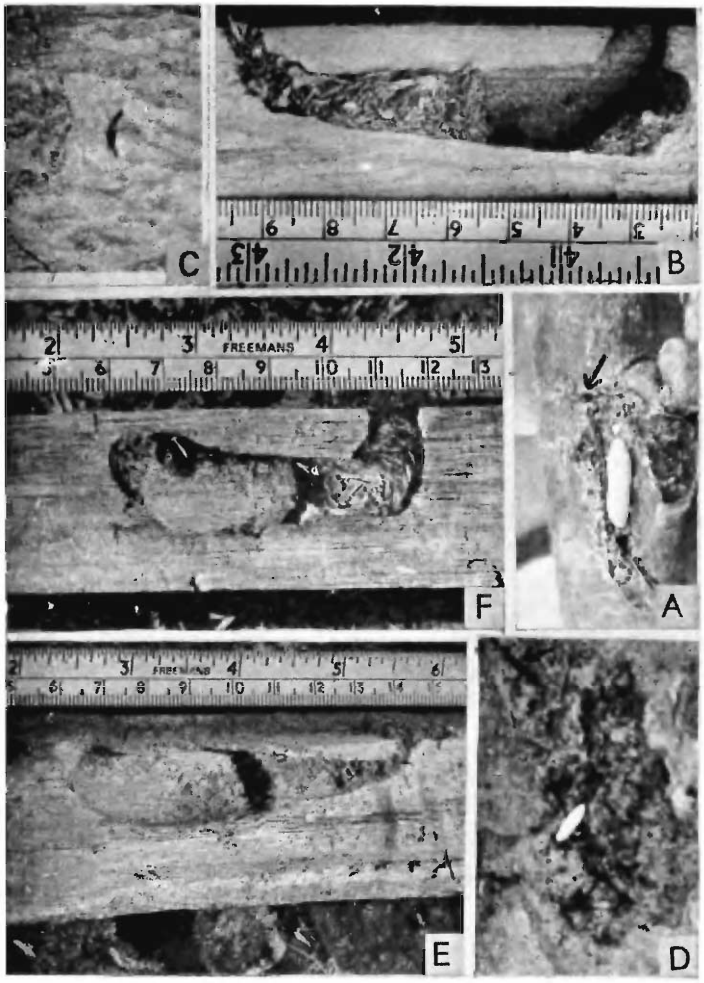
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Plate IX

A. *Acalolepta rusticator* (Fabricius). An emerging adult beetle shown excavating its exit-hole in a log of *Pterocymbium tinctorium.*

B-D. *Batocera rufomaculata* var *andamana* Thomson ;

B. Longitudinal section through the bark of a freshly felled log of *Pterocymbium tinctorium,* showing the egg-pit containing the egg *in situ.*

C. Longitudinal section through the heart-wood of *Artocarpus chaplasha,* showing the pupal chamber with pupa *in situ.*

D. Pupal chamber inside the wood of a large log of *Dipterocarpus* sp.

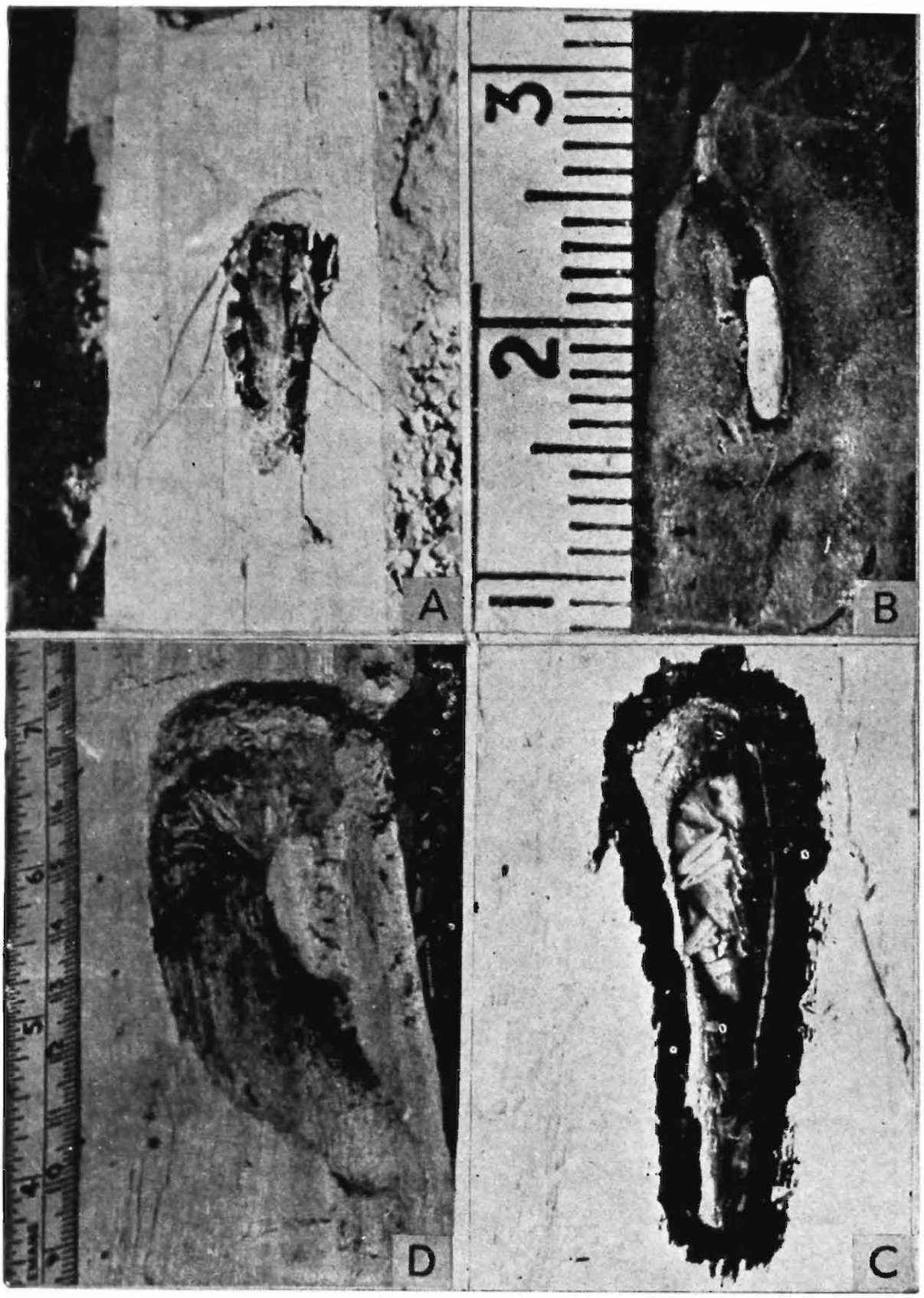
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PLATE X

A-C. *Olenecamptus bilobus* (Fabricius) ;

A. An egg inside the egg-pit within the bark of a freshly felled log of *Artocarpus chaplasha.*

B. Larval galleries on the wood-surface of a log of *Artocarpus chaplasha,* showing the young larva and the tightly packed fibrous frass.

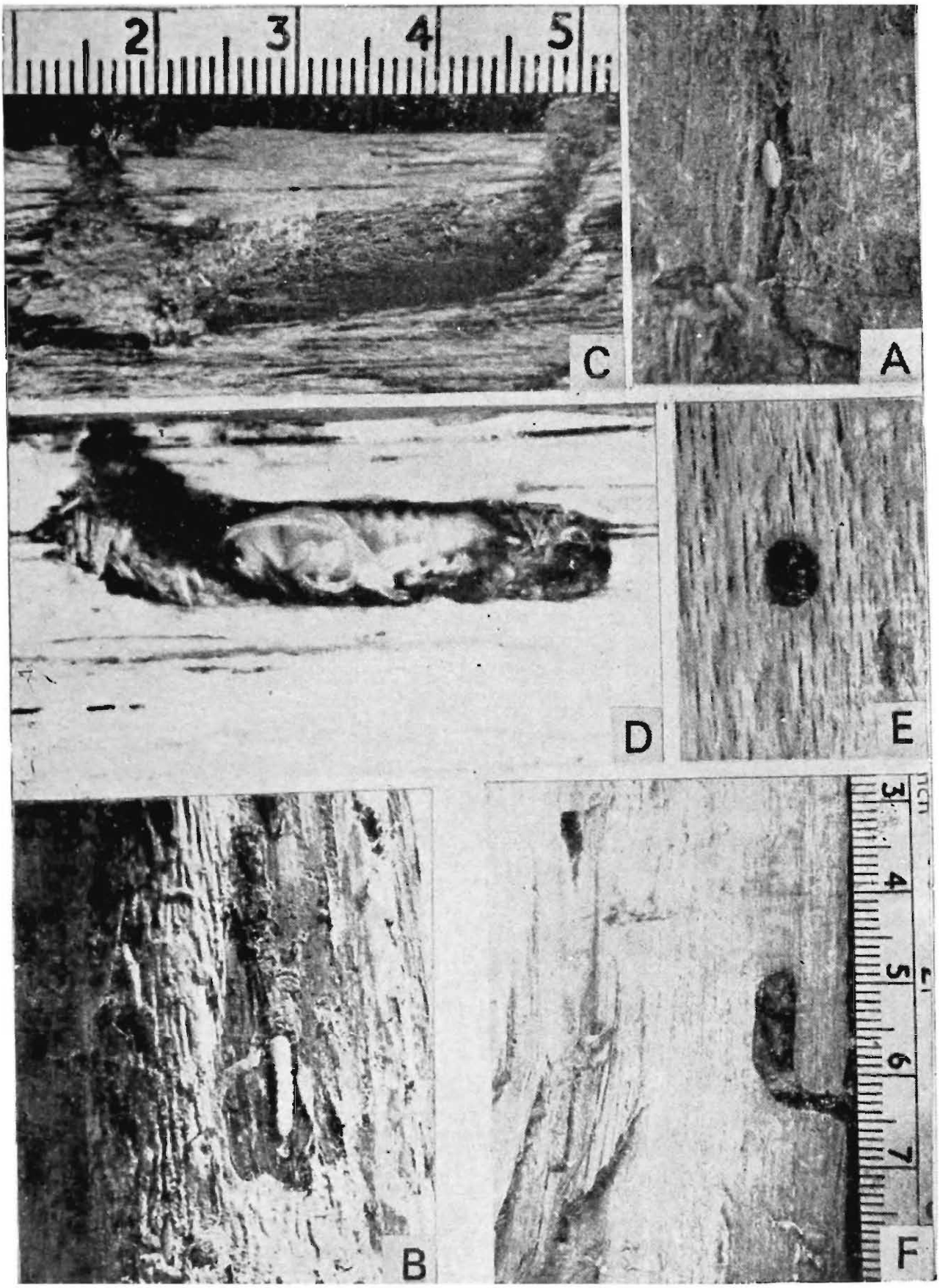
C. Longitudinal section through a log of *Salmalia insignis,* showing the pupal chamber inside the sap-wood.

D and E. *Glenea* (*Stiroglenea*) *andamanica* Breuning ;

D. Longitudinal section through a log of *Pterocymbium tinctorium,* showing the typical pupal chamber inside the sap-wood with pupa *in situ.*

E. Exit-hole, made by the emerging adult beetle, on the wood-surface of *Pterocymbium tinctorium.*

F. *Serixia* (*s.str.*) *andamanica* Gardner. The typical pupal chamber containing the dormant adult inside the sap-wood of a log of *Terminalia bialata,* wherein the plug made of wood fibres sealing the opening of the chamber.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