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LABORATORY STUDIES AND ECOLOGICAL NOTES ON HAWAIIAN SCIARIDAE (Diptera)[1]

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Abstract: Fourteen Hawaiian Sciaridae (Diptera) were studied in the laboratory and reared in constant temperature cabinets at 20° C ±2°. Five of these species are probably endemic. The mean developmental time in days of eggs, larvae and pupae for each species, except *Hyperlasion magnisensoria* (Hardy) is given. Total mean developmental time for each species was as follows: *Bradysia bishopi* Steffan - 18.8; *B. impatiens* (Johannsen) - 16.3; *B. molokaiensis* (Grimshaw) - 16.2; *B. spatitergum* (Hardy) - 17.9; *B. tritici* (Coquillett), "monogenic" - 18.5; *B. tritici* (Coquillett), "digenic" - 22.2; *Corynoptera brevipalpis* Steffan - 34.0; *Ctenosciara hawaiiensis* (Hardy) - 29.0; *Lycoriella hoyti* (Hardy) - 33.0; *L. mali* (Fitch) - 20.0; *L. solispina* (Hardy) - 19.8; *Phytosciara vulcanata* Steffan - 21.5; *Plastosciara perniciosa* Edwards - 27.3 and *Scatopsciara nigrita* Hardy - 24.5.

The probable ecological role for each species is given. Most Hawaiian Sciaridae are either phytosaprophagous or mycetophagous or both. Some are known to be facultatively phytophagous elsewhere and several species are probably faculatively coprophagous. One or more species may be corticolous feeders.

During investigations on the ecology and systematics of Hawaiian Sciaridae, 14 species were reared in the laboratory from December 1967 to March 1971. Laboratory studies are essential for both systematic and ecological research on Sciaridae. The females of many species are impossible to identify until they have been definitely associated with males by rearing. Also study of immature stages will undoubtedly elucidate some of the problems in the higher classification of this family. Ecological research is likewise dependent upon supportive data from laboratory studies, since larvae of Sciaridae are generally very difficult to find in the field.

Most Sciaridae reared in the laboratory by other investigators have been those of economic importance (Del Guercio 1905; Hungerford 1916; Gui 1933; Ellisor 1934; Madwar 1934 and 1937; Wisely 1959; Wilkinson & Daugherty 1970; and Kennedy 1971) and those studied cytologically (Butt 1934; Metz 1938a, b; Carson 1944; McCarthy 1945; Fahmy 1949; Gabrusewycz-Garcia 1964; Pavan et al. 1965; Rieffel & Crouse 1966; Mattingly & Parker 1968; and others). Several different rearing methods have been used and are reviewed by Steffan (1966) and Kennedy (1971).

Two types of reproduction, as indicated by the sex ratio of the progeny from a single female, are found in Sciaridae. One is characterized by production of "monogenic" families; that is, progeny from one female are either all males or all females. Exceptional males or females do occur rarely (Crouse 1960). The other is characterized by a more typical sex ratio, the progeny from one female including more or less equal numbers of both sexes. These are referred to as "digenic" families. Some species have strains displaying both types of reproduction, but most species are characterized by only one.

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METHODS

Several different techniques were used for collecting stock for laboratory cultures. Since it is generally easier to start cultures from gravid females, most field collections were of adults. Adults were usually collected by sweeping various types of vegetation or extracting them from decomposing organic debris. Adults were also attracted to black light and to white sheets placed on the ground. Larvae were collected from rotting wood and under the bark of dead branches.

Laboratory cultures were started from gravid females or larvae collected in the field. The adults or larvae were placed in glass shell vials (25 × 95 mm) containing an agar substrate. This is a modification of a culture method used by Metz and his students (Smith-Stocking 1936) for genetic studies of Sciaridae and is described below. It was reported in Steffan (1966, 1973) and is referred to as the "standard rearing medium" in this paper.

Agar substrate: Mix 4.2 g of Bacto-Corn Meal Agar and 2.0 g of Bacto-agar in 200 ml of distilled water. If excess fungal growth is detrimental to the sciarid culture, a plain Bacto-agar medium can be used. This is prepared by mixing 8 g of Bacto-agar in 200 ml of water. Heat mixture in a pan of boiling water for 10 minutes. Pour approximately 3 cm of this mixture into each vial, plug with cotton and autoclave for 15 minutes. Prepare slants by cooling vials in a diagonal position. Slant cultures are preferred as they provide more surface areas for the larvae and adults so that they are easier to observe and manipulate.

Sprinkle chopped, sterilized straw over the agar surface prior to the introduction of adults or field-collected larvae to remove excess surface moisture and provide a suitable environment for oviposition and larval feeding. Eggs generally hatch within 2—6 days. Larvae are subsequently fed a mixture of finely chopped sterilized straw and Brewer's yeast every 2—3 days. The cultures are maintained in a constant temperature cabinet at 20°C.

Since most of the observations during this 4 - year period were made by various technicians, the only consistent data recorded for each culture were the first observations of oviposition, appearance of lst instar larvae, construction of pupal chambers, pupation and adult emergence. Generally at least 10 vials with one female and two males were prepared for each generation, and observations from only one of these was used for the calculations in Table 1. The data in Table 1 are therefore biased in that they are based on the first appearance of each developmental stage and not the mean for each culture. The mean developmental time for most species probably would be 1—2 days longer than that given in Table 1, which actually represents the minimum mean developmental time.

RESULTS

Bradysia bishopi Steffan

B. bishopi is digenic and very easy to colonize on the standard rearing medium. A single colony was started from a gravid female collected at black light at Kailua, Oahu, 11.XI. 1968 (HW-162). The colony was maintained for 13 generations (286 days). Mean developmental time of eggs, larvae and pupae at 20°C±2° was 18.8 days (Table 1),

with a preoviposition period of 2—3 days. Development was not synchronous as adults from one egg batch emerged over a 3—5 day period, although eggs hatched on the same day. Larvae tended to remain on the surface of the agar and constructed individual cocoons prior to pupation. Males generally emerged a day before the females. Adults lived about 3 days in the culture tubes.

B. bishopi, probably an introduced species, is frequently collected at light on the lowlands on Oahu. This is probably a phytosaprophagous or mycetophagous species. Several adults were reared from a bracket fungus collected on Oahu.

Table 1. Preoviposition and developmental time of Hawaiian Sciaridae at 20°C±2°.

Species	Preoviposition Period (in days)	Mean Developmental Time in Days			
		Egg	Instars I-IV	Pupa	Total
Bradysia bishopi (radicum)	2—3	3.5	12.0	3.3	18.8
Bradysia impatiens	1—3	3.5	9.6	3.9	16.3
Bradysia molokaiensis	3	3.8	9.4	3.0	16.2
Bradysia spatitergum	2—3	3.4	10.9	3.6	17.9
Bradysia tritici "monogenic"	N.A.	3.0	12.2	3.3	18.5
„ „ "digenic"	2—3	4.4	14.2	3.6	22.2
Corynoptera brevipalpis	N.A.	10.0	18.5	5.5	34.0
Ctenosciara hawaiiensis	1—3	4.2	18.2	6.6	29.0
Hyperlasion magnisensoria	N.A.	6.0	8.0+	+	+
Lycoriella hoyti	1—2	6.5	23.0	3.5	33.0
Lycoriella mali	2—4	3.3	13.6	3.1	20.0
Lycoriella solispina	1—3	3.5	12.8	3.5	19.8
Phytosciara vulcanata	1—4	3.9	12.8	4.8	21.5
Plastosciara perniciosa	N.A.	5.7	18.1	3.5	27.3
Scatopsciara nigrita	2—3	4.1	16.8	3.6	24.5

+Culture died out before pupating.
N.A. = not available.

Bradysia impatiens (Johannsen)

B. impatiens is monogenic and also easy to colonize on the standard rearing medium. The parents of this colony were collected in Honolulu and some males were reared from a rotting *Acacia koa* log from Mt. Tantalus, Oahu. The colony was maintained for 14 generations (253 days). Mean developmental time of eggs, larvae, and pupae at 20°C ±2° was 16.3 days (Table 1) with a preoviposition period of 1—3 days. Adults from one batch generally emerged over a 3—4 day period. Larvae tended to remain on the surface of the agar and prior to pupation would construct individual cocoons. Males generally emerged a day before the females. Longevity of the adults was not determined.

B. impatiens is an introduced species commonly found in the lowlands of all major Hawaiian islands, but it is occasionally found up to 2200 m in disturbed habitats. We

have reared it from rotting *Acacia koa* and *Freycinetia*. *B. impatiens* is probably a phytosaprophagous or mycetophagous species, but in some cases can be phytophagous.

B. impatiens was described from adults reared from larvae found in earth adhering to the roots of *Impatiens* (Johannsen 1912). Carson (1944) reared specimens from various eastern and midwestern U. S. localities for his studies on chromosome variability. He indicated that it is common in and around greenhouses and breeds abundantly in the earth and compost mixtures used in greenhouses. He suggests that it may be cosmopolitan since Metz (1929, unpublished) obtained specimens from California and Berlin, Germany. This supports Steffan's opinion based on morphological studies that *B. impatiens* may be conspecific with the Palearctic species *B. fungicola* (Steffan 1973). Roberts & Lavigne (1959) reported that the larvae of *B. impatiens* were observed feeding on the fine root hairs of the turf grass species, *Poa protensis* and *Festuca rubra*. Wilkinson & Daugherty (1970) observed the larvae of *B. impatiens* feeding on the roots of soybean plants in Missouri. They also studied the life history of this species in the laboratory. At 23.9°C, the mean developmental time of *B. impatiens* was 21.6 days. The larvae were reared on a ground soybean medium. Kennedy (1971) studied the importance of fungi in the development of *B. impatiens* and at 20°C reported a mean developmental time of 21.6 days. He compares his results with those of Wilkinson & Daugherty.

The mean developmental time of 16.3 days at 20°C of the Hawaiian *B. impatiens* is considerably faster than that reported by Kennedy or Wilkinson & Daugherty. In part, experimental methods could account for this discrepancy. The data for the Hawaiian populations was based on the first observance of each stage; the mean developmental time for the progeny from any one batch of eggs would be at least 1 or 2 days longer. A number of factors could influence the development of these various strains in the laboratory. Kennedy (1971) mentions variations in laboratory strains, photoperiod and larval diet. The cytological investigations of Carson (1944) certainly indicate this is a highly variable species. A complex of very closely related species may also be involved. In any case, these discrepancies in developmental time point out the importance of standardizing rearing methods for comparative studies.

Bradysia molokaiensis (Grimshaw)

B. molokaiensis is monogenic and difficult to colonize. During 1968, 1969, and 1970, 30 cultures were attempted and only 17 (57%) yielded F_1 progeny. Only one colony produced a 4th generation, which died out. Part of the difficulty was caused by the fact that this species is monogenic. Colonies were frequently lost when only one sex was produced. However, other monogenic species such as *B. impatiens* were very easy to colonize so other factors are involved. All colonies were started from adults collected on Oahu. Mean developmental time of eggs, larvae and pupae at 20°C ±2° was 16.2 days (Table 1). Preoviposition period was 3 days. Mated females frequently died before oviposition possibly indicating that the oviposition site was not favorable. Adults emerged over a 3—5 day period. Larvae remained on the surface and constructed individual cocoons prior to pupation. Males usually emerged one day before females.

B. molokaiensis, probably endemic, is a common lowland species on all major Hawaiian islands and is usually collected at light. It has been collected up to 2200 m. We have collected it by sweeping low herbs and grasses in cattle pens and from rotting sugar

cane. *B. molokaiensis* may also be phytosaprophagous or mycetophagous.

Bradysia spatitergum (Hardy)

B. spatitergum is monogenic, but exceptional males or females will occur occasionally. It is easy to colonize on the standard rearing medium. Eleven cultures were attempted and 10 (91%) were successful. One colony was maintained for 9 generations (195 days). Mean developmental time of eggs, larvae and pupae at 20°C±2° was 17.9 days (Table 1) with a preoviposition period of 2—3 days. Adults from one egg batch emerged over a 3—4 day period. Larvae tended to remain on the surface of the agar and constructed individual cocoons prior to pupation. Males generally emerged one day before females.

B. spatitergum, an introduced species, is common in the lowlands of all major Hawaiian islands and is frequently collected at light. It was reported from rotting sugar cane, rotting sweet potatoes, and from coffee grounds (Hardy 1960). It has also been reared from rotting logs, bracken fern, *Pisonia* logs, *Reynoldsia* stems, *Urera* wood and *Marottia* ferns (Montgomery, unpubl., Steffan, unpubl.). It has also been reared from the puparium of the New Guinea sugar cane weevil (Mitchell, unpubl.). Specimens from Panama were collected on *Heliotropium peruvianum* L. (=*H. arborescens* L.) and on flowers and fruit of *Heliconia mariae* Hook (Steffan 1968). Both *H. arborescens* and *H. mariae* have been introduced into Hawaii. Specimens of *B. spatitergum* from Brazil were collected on fermenting sweet potato leaves (Steffan 1968). *B. spatitergum* is probably phytosaprophagous or mycetophagous.

Bradysia tritici (Coquillett)

Both monogenic and digenic strains of *B. tritici* are reported in the literature (Metz & Lawrence 1938; Crouse 1939, as *S. ocellaris*). We apparently have both strains in Hawaii; however, the monogenic strain is more common. Both strains are easy to colonize on the standard rearing medium The digenic *B. tritici* was maintained for 8 generations (210 days). Mean developmental time for digenic *B. tritici* (eggs, larvae and pupae) was 22.2 days (range 14—23 days) (Table 1). The mean developmental time for monogenic *B. tritici* was shorter (18.5 days, range 19—28 days). Adults from one egg batch tended to emerge over a 2—5 day period. Larvae tended to remain on the surface of the agar and constructed individual pupal cocoons. Males usually emerged before females in both strains.

B. tritici is a common lowland species on all major Hawaiian islands and probably occurs on the smaller islands of the Hawaiian Chain also. Hardy (1960) indicated that it (as *S. garretti* Shaw) was probably an immigrant species, and this has been confirmed. It is a cosmopolitan species commonly found in greenhouses. *B. tritici* has been reared from decaying sugar cane, pineapple, commercial mushrooms and other plants (Hardy 1960). *B. tritici* was originally reported destructive to wheat seedlings (Coquillett 1895). Kennedy (1971) in his review of sciarid species attacking cultivated crops lists the following plants attracted by *B. tritici* (as *S. ocellaris*): campanula, carnations, corn, cucumbers, geraniums, lettuce, Nasturtium, orchids, peas, potato tubers, primula and wheat. We have reared it from rotting logs, rotting *Acacia koa*, and have frequently collected it at black light and in Malaise traps. *B. tritici* is phytosaprophagous, mycetophagous and, in some cases, phytophagous.

Corynoptera brevipalpis Steffan

C. brevipalpis is digenic and probably would be difficult to colonize on the standard rearing medium. Four cultures were attempted and two produced F_1 adults. F_1 females oviposited but the temperature cabinet overheated killing all colonies. The parent adults were reared from rotting *Acacia koa* wood collected on Mt. Tantalus, Oahu, 20.XI.1968. Mean developmental time for eggs, larvae and pupae at 20°C±2° was 34.0 days. High mortality rate was noted in the larval stages. Larvae did not construct pupal cocoons. Pupae were bright yellow immediately after pupation and gradually darkened.

C. brevipalpis is probably a mycetophagous species. It is an introduced species and known from the Caroline Islands, Micronesia (Steffan 1969).

Ctenosciara hawaiiensis (Hardy)

C. hawaiiensis is monogenic and difficult to colonize. Females usually did not oviposit readily on our agar slant cultures. Twenty-eight cultures were attempted and only 8 (28%) were successful. Of these, only one was maintained for 3 generations. Mean developmental time of eggs, larvae and pupae at 20°C±2° was 29.0 days (Table 1), with a preoviposition period of 1-3 days. Adults from one egg batch emerged over a 5-8 day period. Larvae frequently burrowed into the agar medium or between the agar and the glass vial. Larvae constructed individual pupal cocoons. Larval development was not synchronous and larvae were not gregarious as are those of some sciards.

C. hawaiiensis, an endemic species, is common on all Hawaiian islands and is generally found above 450 m. It has been reared from rotting wood and *Freycinetia* (Hardy 1956, 1960). We have collected it from rotting *Ohia*, *Pipturus*, and *Acacia koa*. In ecological studies on the island of Hawaii, *C. hawaiiensis* seems to be closely associated with *Acacia koa*, one of the dominant elements of the plant community (Steffan 1973). Thousands of adults have been observed flying over the surface of a large, fallen *Acacia koa*. Most adults captured in this situation were males and they were apparently searching for females among the deep crevices of bark. In the same area, larvae of *C. hawaiiensis* were commonly found under the bark of dead *A. koa* branches. Seasonal fluctuations of *C. hawaiiensis* have also been studied (Steffan 1973). Adults have also been captured while resting in the axils of *Freycinetia* sp. *C. hawaiiensis* is probably phytosaprophagous and, in some cases, may be a corticolous feeder.

Hyperlasion magnisensoria (Hardy)

H. magnisensoria was reared to the 4th instar only. Developmental time of the eggs at 20°C±2° was 6 days and the larvae lived for 8 days (Table 1). Larvae of *H. magnisensoria* were collected on fallen *Coprosoma* logs covered with moss. The larvae were feeding on the surface of the wood under the thick mat of moss.

H. magnisensoria, an endemic species, occurs in the mountains of all major islands in Hawaii. It probably breeds primarily in litter and is phytosaprophagous or mycetophagous.

Lycoriella hoyti (Hardy)

L. hoyti is apparently digenic and easy to colonize on the standard rearing medium. The one attempt to colonize this species was successful and it was maintained for 7 generations. Records are available for F_4 only so the data in Table 1 is based on 3 cultures only. Mean developmental time for the eggs, larvae and pupae at 20°C±2° is 33.0 days with a preoviposition period of 1—2 days.

L. hoyti, probably endemic, is known from the mountains of Oahu, Maui, and Hawaii I. It has been reared from moss. Adults have been collected from rotting haupu (*Cibotium* sp.) and rotting *Acacia koa* on Hawaii I. *L. hoyti* is probably phytosaprophagous or mycetophagous.

Lycoriella mali (Fitch)

L. mali is digenic and easy to colonize on the standard rearing medium. The one attempt to colonize this species was successful and the colony was maintained for 12 generations (277 days). Mean developmental time of eggs, larvae, and pupae at 20°C± 2° was 20.0 days with a preoviposition period of 2—4 days. Larvae constructed individual cocoons prior to pupation. Males generally emerged a day before females.

In Hawaii *L. mali* has been found at Kokee on the island of Kauai and may be a fairly recent introduction. It is widespread in North America where it is found in British Columbia, California, Ontario and from New Hampshire to Pennsylvania and New Jersey. In North America it has been reared from rotting apples and rotting potatoes and it is commonly found in greenhouses. This species has been studied cytologically (McCarthy 1945). *L. mali* is probably phytosaprophagous or mycetophagous.

Lycoriella solispina (Hardy)

L. solispina is monogenic and easy to rear on the standard rearing medium. Two cultures were attempted and both were successful. One was maintained for 10 generations (251 days) and was started from females collected on flowering *Acacia koa* in open range land on the north slope of Mauna Kea, Hawaii I., 1585 m., 3.XII.1968; W. Gagné collector. Mean developmental time at 20°C±2° of eggs, larvae and pupae was 19.8 days with a preoviposition period of 1—3 days. Larvae tended to remain on the surface of the agar and prior to pupation constructed individual pupal cocoons. Adults from one egg batch emerged over a 3—4 day period. There may be some genetic markers in this strain since adults with crumpled wings and deformed antennae frequently appeared. Some of the adults in a few culture vials were occasionally destroyed by nematodes.

L. solispina is apparently an introduced species very similar to or conspecific with *L. similans* Johannsen. It has been collected only on Hawaii I. at 1585—2134 m. *L. similans*, as investigated by Metz (1926), has both monogenic and digenic strains. *L. solispina* may be phytosaprophagous or mycetophagous.

Phytosciara vulcanata Steffan

P. vulcanata is digenic and easy to rear on the standard rearing medium. One colony was maintained for 11 generations (255 days). Mean developmental time at 20°C ±2° for eggs, larvae and pupae was 21.5 days with a preoviposition period of 1—4 days. Larvae seem to be gregarious and more or less synchronous in development. Single pupal cocoons are constructed prior to pupation. Generally from a single egg batch, one sex will be more common although both are always present. Males emerge about a day before females.

P. vulcanata has been collected in the mountains of Hawaii and Maui I. It is the only species collected in lava tubes by F. Howarth. It was reared from decomposing rat feces. *P. vulcanata* is probably phytosaprophagous, mycetophagous and, in some cases, coprophagous.

Plastosciara perniciosa Edwards

P. perniciosa is digenic and very easy to rear on the standard rearing medium. Eight of 9 cultures attempted were successful and one colony was maintained for 28 generations. Mean developmental time at 20°C±2° was 27.3 days (Table 1).

This is the most unusual sciarid encountered in that both males and females may be either fully winged or micropterous. The larvae of normally winged adults fed on the surface of the agar and constructed individual cocoons prior to pupation. Larvae of apterous adults burrowed into the agar and constructed enlarged pupal chambers generally enclosing 2 females and 1 male.

P. perniciosa (=*P. brevicalcarata* Hardy) is commonly taken indoors. It is apparently a cosmopolitan species. We have collected it in Malaise traps and have reared it from rotting wood. In England it is a common greenhouse pest and larvae are destructive on cucumbers, feeding in the roots and stems. On Mt Kaala, Oahu, a micropterous male was collected from the surface of a dead branch of *Coprosoma* covered with moss. *P. perniciosa* is phytosaprophagous, mycetophagous and, in some cases, phytophagous.

Scatopsciara nigrita Hardy

S. nigrita is digenic and relatively easy to rear on the standard rearing medium. After the F_4 generation, the gravid females frequently died before oviposition. One colony was maintained for 9 generations (255 days), but with decreasing vigor. Mean developmental time at 20°C±2° of eggs, larvae and pupae is 24.5 days (Table 1). Larvae tended to remain on the surface of the agar and prior to pupation constructed individual cocoons.

S. nigrita, an endemic species, is known from the islands of Hawaii and Oahu and is fairly common at lights, on windows, and in rotting vegetation (Hardy 1960). The single colony was started from females collected at Peacock Flat, Oahu, 450 m, in a shaded creek bottom with kukui trees, *Pipturus* and rotting logs. An additional collection from Peacock Flat was reared from rotting logs. *S. nigrita* is probably phytosaprophagous or mycetophagous.

DISCUSSION

Most Hawaiian Sciaridae appear to be phytosaprophagous or mycetophagous or both. It is difficult to determine whether the larvae are feeding primarily on dead plant materi or on fungi impregnating the dead plant material. They usually consume both in the laboratory cultures. They also consume any other organic material in the culture vials, including the dead bodies of adult sciarids. Occasionally, the larvae attack and consume other weakened larvae and in some cases, especially in crowded cultures, will attack and consume healthy pupae not enclosed in cocoons. *C. hawaiiensis* may be corticolous but is also phytosaprophagous or mycdtophagous.

B. impatiens, *B. tritici* and *P. perniciosa* are reported to be phytophagous in some cases, but I suspect they are primarily phytosaprophagous or mycetophagous. *P. vulcanata* and *B. molokaiensis* and perhaps several other Hawaiian sciarids may be facultative coprophagous.

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BOOK NOTICES

The Association for the Study of Oriental Insects (c/o Dept Zoology, University of Delhi, Delhi - 7, India), regularly publishes the journal ORIENTAL INSECTS, of which volume 8 will be published in 1974.

Two adjunct series of the above journal have been initiated, as follows:

ORIENTAL INSECTS SUPPLEMENTS

Number 1. Studies on Indian Agromyzidae (Diptera). 1971. 282 p. Rs. 50/- (India); US$9.00 or £3.50. This consists of 15 articles, 2 by Ipe and Beri, 7 by Beri, and 6 by Garg. The papers concern both systematics and biology, and contain many keys and illustrations

Number 2. Studies on Oriental Pipunculidae (Diptera). 1972. By D. Elmo Hardy. Rs 25/- (India); $5.00 or £2.00. Keys and descriptions, with illustrations.

Number 3. The fleas (Siphonaptera) of the Indian Subregion. By Ravi Iyengar. 1973. Rs 25/- (India); $5.00 or £2.00. Keys and descriptions, with illustrations.

ORIENTAL INSECTS MONOGRAPHS

Monograph 1. Ichneumonologia Orientalis, Part 1.—Tribe Pimplini. By V. K. Gupta and D. T. Tikar. 1972. Rs 100/- (India); £6.20; $16.00.

Monograph 2. Ichneumonologia Orientalis, Part II. The tribe Rhyssini. By M. K. Kamath & V. K. Gupta. 1972. 300 p. Rs 100/- (India); £6.20; $16.00.

Monograph 3. Ichneumonologia Orientalis, Part III. The Goryphus-complex. By J. K. Jonathan & V. K. Gupta. 203 p. Rs 100/- (India); £6.20; $16.00.

This series of monographs contains keys, descriptions, distributional tables and maps, and numerous illustrations. Printing and format are clear and effective.