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'J'engage donc tous à éviter dans leurs écrits toute personnalité, toute expression dépassant les limites de la discussion la plus sincère et la plus courtoise.'—*Laboulbène.*

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STUDIES ON THE BIOLOGY OF THE GERRIDAE (HEM., HETEROPTERA) II: THE LIFE HISTORY OF *METROCORIS TENUICORNIS* ESAKI

By Lanna Cheng

Life history studies on the south-east Asian Gerridae have only been carried out on the still-water species *Limnogonus fossarum* (F.) and *Rhagadotarsus kraepelini* Bredd. in China (Hoffmann, 1936a, 1936b), and *Limnometra fluviorum* (F.) in India (Tonapi, 1959; Tonapi & Karandikar, 1961). No attempts have hitherto been made to study the life history of any of the running-water Gerridae. *Metrocoris tenuicornis* Esaki was chosen for this study as it was fairly common in forest streams in Singapore.

Material and Methods

Several adult females were collected from Sungai Seletar which is a fairly fast flowing forest stream in Singapore, and kept in a tank of dimensions 4 x 8 x 4 feet in the Department of Zoology, University of Singapore. The water level in the tank was kept about 6–10 inches below the brim during the whole period of study to prevent the gerrids from jumping out. Constant disturbance of the water surface was maintained by continuous bubbling of compressed air so as to give an environment as close to the natural habitat as possible. The common floating water plants, *Salvinia* (Filicales, Salviniaceae) and *Pistia* (Monocot., Araceae), and some stones were provided for shade and resting places. Laboratory reared *Drosophila melanogaster* Meigen was used as food.

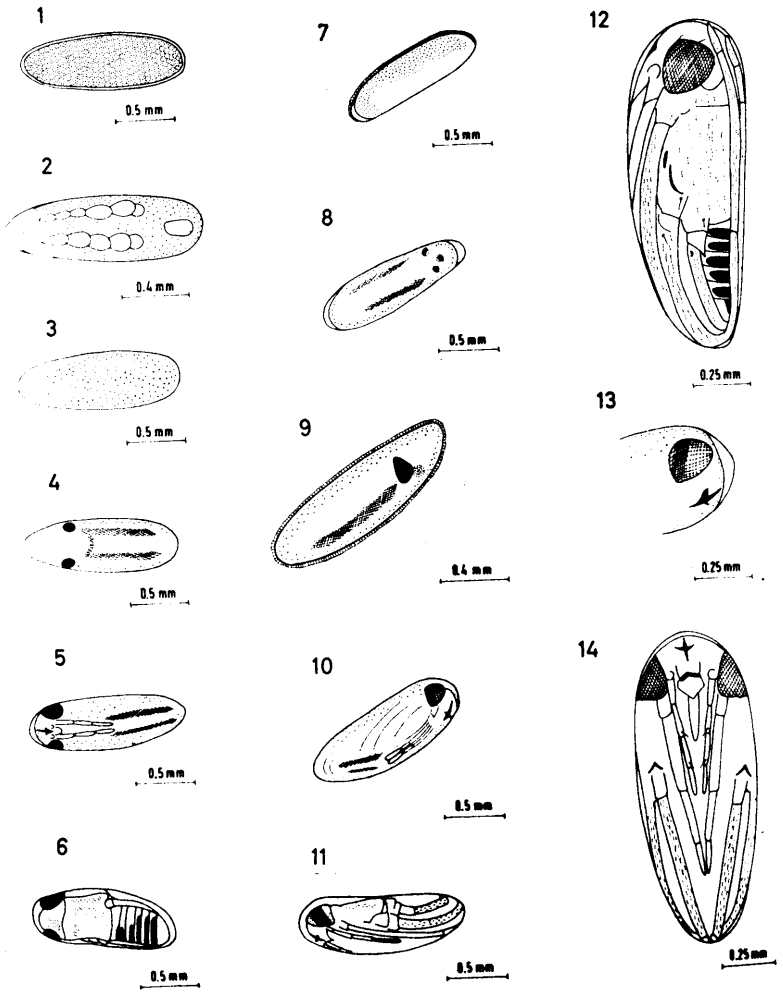
About 20 days after the transfer from the field, nymphs of three different stages were found in the tank. These were reared on *Drosophila* till maturity. Observations on mating behaviour and subsequently on the development of the egg and nymphal stages were made on individuals reared in the laboratory.

Observations

Mating and oviposition.—Mating was first seen on September 9th, 1964, and a mating pair was transferred from the tank to an aquarium with glass sides (1 x 1½ x 1 feet) in the laboratory to facilitate frequent observations. A continuous current was maintained in the aquarium by bubbling compressed air through it. Mating occurred at infrequent and irregular intervals, each copulation lasting only 5–10 minutes.

No distinct territorial behaviour was observed in the tank, though each male tended to keep a small area around any particular female clear of other males, chasing away any male entering this area. There was no constant partnership, partners being changed quite readily. The male was observed to jump on the back of the female without any obvious pre-mating display, and if accepted, remained *in copula* for 5–10 minutes. During mating, the female kept almost motionless while the male (which in this species is much larger than the female) kept moving slowly, carrying the passive female below. In species with males much

smaller than the females, such as *Rheumatogonus intermedius* Hungerford, I have observed females carrying motionless males on their backs during mating.



Figs. 1–14.—Development of the egg of *Metrocoris tenuicornis* Esaki: 1, 1st day, dorsal view; 2, 2nd day, dorsal view,; 3 3rd day, dorsal view; 4, 5th day, dorsal view; 5, 7th day, dorsal view; 6, 8th day, ventral view; 7, 2nd day, lateral view; 8, 3rd day, ventral view; 9, 5th day, lateral view; 10, 7th day, lateral view; 11, 8th day, lateral view; 12, 9th day, lateral view; 13, 7th day, lateral view showing egg burster; 14, 10th day, ventral view.

Oviposition was not observed. The first eggs were found on September 27th, 18 days after the first mating was observed. The eggs were laid singly, glued to the under-water roots of the floating plants.

A few were laid glued along their lengths to the glass walls of the aquarium 3–4 mm. below the water surface. The attachment was loose and the eggs could be detached easily.

The female died on October 2nd, after laying 16 eggs; the male died a day later.

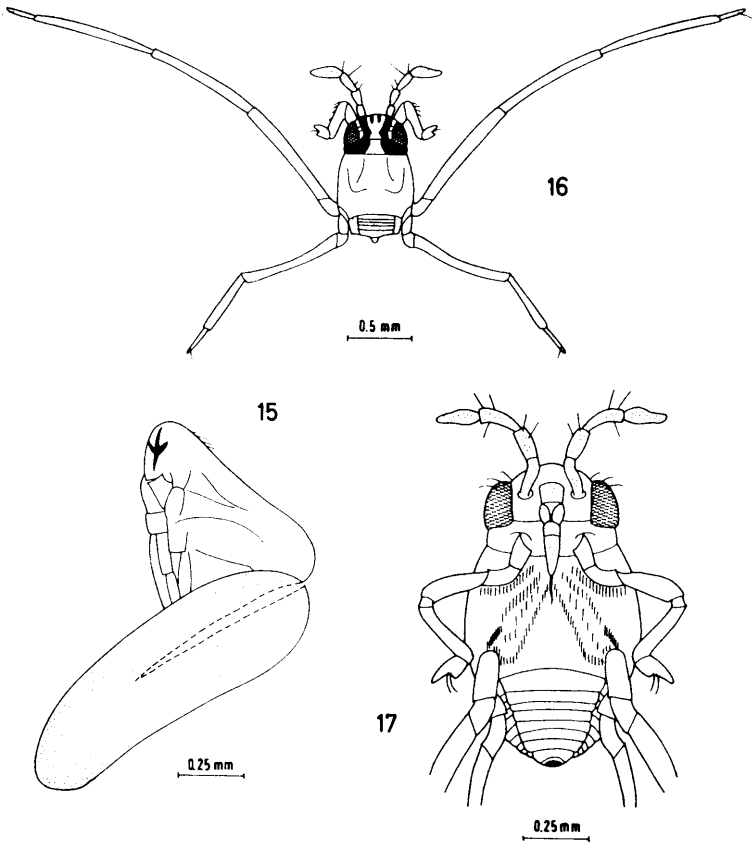
Development of the egg.—Several eggs were detached and maintained in petri dishes lined with filter paper and flooded with water until they hatched. Drawings of the eggs were made with the help of a camera lucida without removing them from their containers.

The opaque white eggs measured 1.03–1.13 mm. x 0.33–0.41 mm. with one end bluntly pointed, the other rounded. The surface by which an egg had been attached was almost flat whilst the other was convex. The outer membrane was about 10μ in thickness and without obvious sculpturing. Fine irregular markings could only be seen after clearing. Throughout the period of development, the size of the egg remained unchanged. Owing to the transparency of the outer membrance of the eggs, the development of the embryo could be observed easily with the help of a binocular microscope. The embryo, unlike that of Notonectidae, did not rotate from time to time during its development (Davis, 1964). It was first observed to move only a few hours before hatching.

1st day: white and opaque (fig. 1).
2nd day: largely white, translucent pale grey areas marking positions of head and legs (figs. 2 & 7).
3rd day: yellow areas marking positions of eyes; head and leg regions yellowish (figs. 3 & 8).
4th day: eyes spots orange; head and leg regions yellow.
5th day: eye spots bright red; region between eye spots orange marking position of egg burster; head and leg regions yellow (figs. 4 & 9).
6th day: eye spots crimson; black egg burster between eyes; orange patches marking positions of last antennal segments; head and leg regions yellow.
7th day: eye spots crimson at anterior half, dark red at posterior half; egg burster clearly distinguishable; last antennal segments orange, rest of the segments yellow; head region yellow; leg regions largely yellow with traces of leg segments appearing as grey patches (figs. 5, 10 & 13).
8th day: eye spots unchanged; antennal segments well differentiated with last segments orange and the remaining segments yellow; leg segments differentiated and grey; rostrum and head visible and light brown (figs. 6 & 11).
9th day: colour of eyes and antennae unchanged; leg segments grey except front femur, orange; black hairs on mid and hind femora; abdominal segments distinguishable during latter half of the 9th day; rostrum and head brown (fig. 12).
10th day: the egg, previously pale grey in colour during the period of development turned dark grey to almost black; eye colour unchanged; rostrum, head, antennae, legs and all segments of the abdomen brown and clearly distinguishable; hatching occurred on the 10th day for the particular egg under observation (fig. 14).

Hatching.—The egg was kept under constant observation during hatching. About an hour before hatching, the head of the embryo began occasionally to move up and down a little. Shortly before hatching, the abdomen began to contract violently. After three or four such contractions in rapid succession, the egg was suddenly split open lengthwise by the egg burster. The nymph then struggled out from the split. The head emerged first followed by the abdomen, then

the fore-legs were drawn out and lastly the middle- and hind-legs which had been neatly tucked above the abdomen during development. Hatching was completed in about three minutes. The embryonic membrane and the egg burster adhered to the remains of the egg (fig. 15).



Figs. 15–17.—*Metrocoris tenuicornis* Esaki: 15, embryonic membrane and remains of egg; 16, newly hatched nymph; 17, 1st instar nymph, ventral view showing hairs.

Hatching was observed during the morning and afternoon, though it probably occurred mostly during the night or early morning, the majority hatching between 10 p.m. and 8 a.m. The temperature of the water in the aquarium during the period of study was between 73–79°F., being highest at about 8 a.m. Owing to the air-conditioning in the laboratory during the day from 9 a.m. till 6 p.m., the temperature rose during the night and reached a maximum at about 8 a.m. This rise in temperature might have had an effect on hatching.

Behaviour of the newly hatched nymphs.—The nymphs hatched under water and remained there for several minutes before struggling to the surface. Some nymphs took 5–10 minutes to do this while others took almost an hour. The legs appeared very weak and soft on hatching, but soon stiffened. After reaching the surface, the nymphs kept quite motionless with legs well spread out for several minutes (fig. 16). They then moved their middle-legs occasionally, but the antennae, fore- and hind-legs remained motionless. Most of them began to skate about an hour after hatching, but moved only slowly. Movements were very feeble and jerky during this period. Normal skating movements were only seen about five hours later.

The newly hatched nymphs were very pale in colour with bright red eyes, light grey, almost transparent appendages, and the venter covered with light brown hairs (fig. 17). Dark markings usually began to appear about 30 minutes after hatching and typical colour patterns were shown three to five hours later. Some nymphs remained pale for one or two hours, only attaining the normal colour pattern nine to ten hours later.

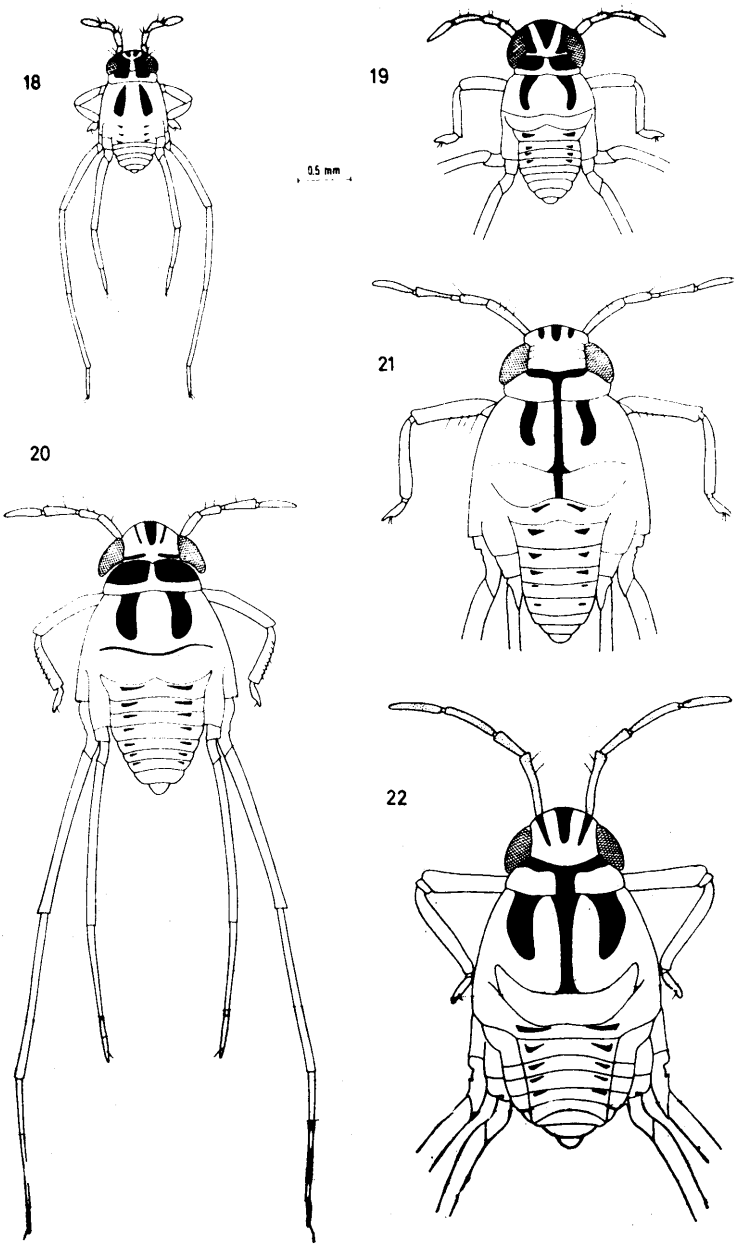
Freshly killed *Drosophila* were dropped into the container, but the newly hatched nymphs ignored them. A day later, the nymphs did show some interest in the flies and several attempted to feed, apparently without success. Most of the nymphs reared in the aquarium died two or three days after hatching though many survived in the tank. Whether these nymphs fed mainly on the numerous small organisms (Copepods, Ostracods, Planarians, etc.) in the tank or on other nymphs was not known. Cannibalism had been noted both in the laboratory and in the field.

Development of the nymphal stages (figs. 18–22).—The duration of different nymphal stages varied from 5 to 10 days. Owing to the high mortality of the earlier nymphs, it was not possible to follow any one nymph from the first instar till sexual maturity in the laboratory. Studies on different nymphal stages were made on different individuals.

The nymphs of different stages do not differ very much in colour pattern from the adults. Each stage could be easily separated from the other by measurements of the relative lengths of antennal and leg segments and to some extent by size. It was found that there was much variation in body length among individuals of the same instar, specially those of the first two instars, owing to the telescopic abdomen. There was less variation in width.

Sexes were not distinguishable morphologically until the 5th instar. At the 5th instar, there was marked difference between the sexes in size as well as body structure. The males were larger with very much longer appendages and the last abdominal ventrite was divided whereas in the females it remained entire as in the earlier nymphs.

The behaviour of the first two instars differed considerably from the later ones and adults. These nymphs were rarely seen in the field and then only near the vegetation at the edges of streams where there was very little disturbance of the water surface. Even in the tank, they kept very much to the edges. The later nymphs and the adults were often found moving up and down in the centre of streams apparently



Figs. 18–22.—Nymphal stages of *Metrocoris tenuicornis* Esaki, dorsal view: 18, 1st instar; 19, 2nd instar; 20, 3rd instar; 21, 4th instar; 22, 5th instar male.

not affected by the water current which might be quite strong. Nymphs of the first three instars were to some extent cannibalistic, those of the later instars rarely so. They fed readily on ants, flies, and other insects that were dropped onto the water surface both in the laboratory and in the field. On several occasions, they were observed to feed on spiders given to them.

The mortality of the early nymphs was very high in the laboratory, only about 10 per cent surviving the first two moults. The mortality of the older nymphs was much lower, about 40 per cent of the third instar nymphs surviving to reach sexual maturity.

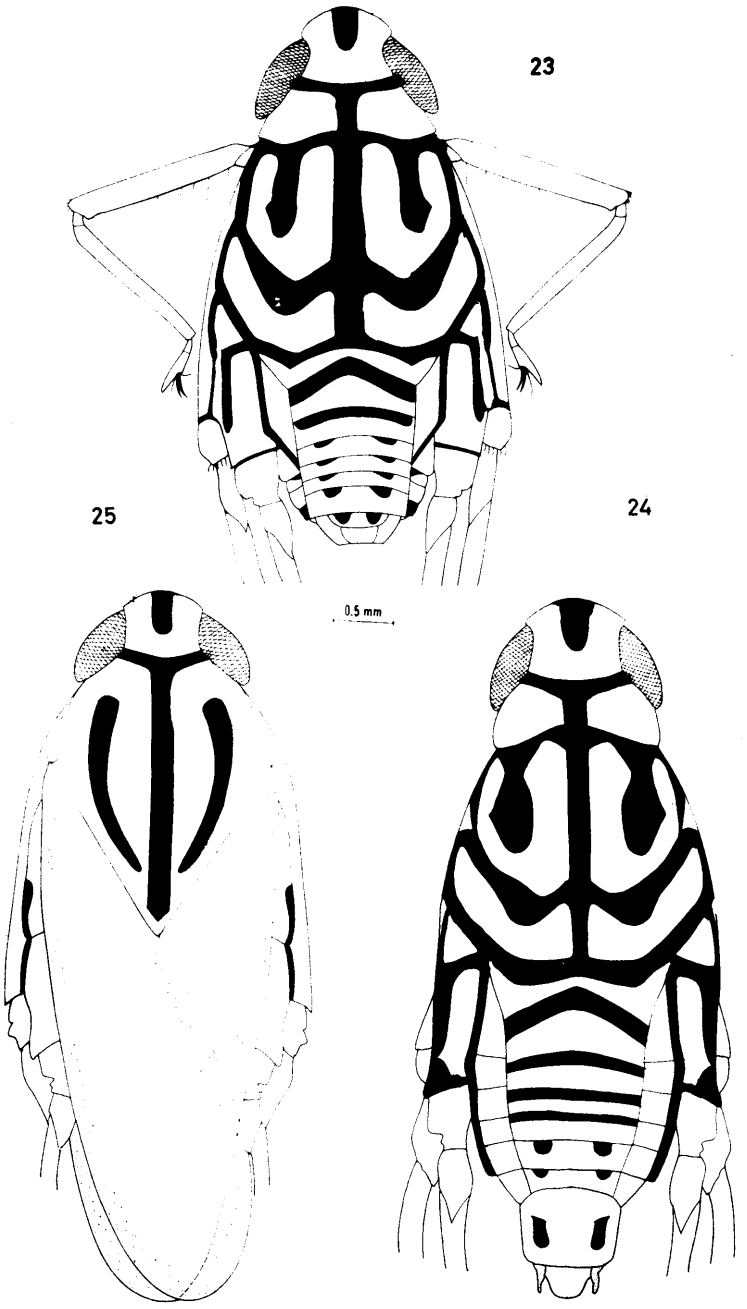
Moulting was never observed in the laboratory between 8 a.m. and 10 p.m., but cast skins were always found in the morning. Individuals about to moult became clumsier in movements and did not respond readily to food. They rested on the leaves of the floating plants or other supports and only moved away when disturbed. Moulting most probably took place at these resting places as cast skins were invariably found on them. The split through which the nymph emerged was Y-shaped with the fork on the head and the stem extending to the anterior region of the abdomen.

During and soon after moulting, the gerrids were presumably more vulnerable to predators such as adult Zygoptera (personal communication, Dr. J. I. Furtado), insectivorous fishes and other predacious animals (Hoffmann, 1936a, 1936b). Examination of gut contents of several insectivorous fishes and frogs, however, did not reveal any remains of gerrids. Bullock (1966) found that gerrids formed 52 per cent of the stomach content of *Rana erythraea* (Schlegel) on Tioman Island, Malaya. They were apparently very important in the diet of this species.

Adult stages.—The adult males were larger than the females with very much longer antennae and legs. The colour pattern on the body was very similar in both sexes (figs. 23 & 24), but that of the legs was different. In the male, the anterior third and posterior third of the middle femur, and the anterior half of the hind femur were white whilst the remaining parts of the legs were brown. In the female, the femora were evenly brown. The males could therefore be easily separated from the females in the field by their larger size and patterned legs.

All the adults reared in the laboratory were wingless except for a single female which had well developed dark brown wings. The winged female was similar in body structure to the wingless forms, but the colour pattern was slightly different (fig. 25). In the field, winged specimens of this species were very rarely collected. The fact that this species only occurred in permanent habitats might account for the rarity of winged forms. Young (1965) also noted the tendency in populations of Corixidae in permanent habitats to be largely flightless.

Alary polymorphism of the Gerridae has been widely studied in temperate countries and has been found to be controlled by both environmental and genetical factors (Ekblom, 1941; Brinkhurst, 1959, 1961, 1963; Usinger, 1956). Southwood (1961) has proposed a hormonal theory.



Figs. 23–25.—Adults of *Metrocoris tenuicornis* 23, female; 24, male; 25, winged female.

Table I gives the average duration of each instar, the size and relative lengths of antennal segments 1–4 of the nymphs and adults. Data are obtained from averages of varying numbers of individuals (shown in brackets).

TABLE 1.—AVERAGE DURATION OF EACH INSTAR, SIZE AND RELATIVE LENGTHS OF ANTENNAL SEGMENTS OF NYMPHS AND ADULTS.

Duration days	*Instar* no.	*Length* in mm.	*Width* in mm.	*Antennal segments* 30 units=1 mm.
5	1st (10)	0.73–1.23	0.47–0.60	4:3:5:6
6	2nd (3)	0.80–1.83	0.77–1.00	6:4:6:8
10	3rd (5)	2.17–2.83	1.13–1.67	12:7:10:10
10	4th (3)	2.00–2.87	1.27–1.40	18:8:13:12
10	5th♂ (1)	3.57	1.83	37:14:19:16
10	5th♀ (2)	2.93–3.47	1.43–1.77	23:10:15:13
	adult ♂ (3)	4.67–5.00	2.27–2.47	56:21:28:19
	adult ♀ (5)	3.60–4.33	2.13–2.33	44:15:22:17
	winged ♀	3.60	2.27	44:16:22:17

CONCLUSION

Three consecutive generations of *Metrocoris tenuicornis* were studied in the laboratory and observations were made in the field at the same time for comparison. The eggs took about 10 days to hatch, and the nymphal stages lasted about 40 days. Mating occurred soon after the adult stage was reached and eggs were laid two to three weeks later. Each generation, therefore, took about 60 days. At any one time, nymphs of different stages and also adults could be found both in the laboratory and in the field. This could be the result of variation in times of oviposition and development.

There seemed to be no definite breeding season, as nymphs were collected throughout the year. It appeared likely that gerrids breed all the year round in Malaya. In this case, there could be five or six generations a year. This contrasted with the position in temperate countries where gerrids have only one or two generations a year, most of them overwintering as adults (Hungerford, 1920; Brinkhurst, 1959).

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October 7th, 1966.

Review

'Die Käfer Mitteleuropas: Band I.' By H. Freude, K. W. Harde & G. A. Lohse. 24 x 17 cms, 214 pp. Goecke & Evers, Krefeld, 1965. Price £3 3s. 6d.

The authors of this volume have embarked on the task of producing a comprehensive work on the central European beetle fauna, scheduled to be completed in eleven volumes; this first one provides a general account of the group, methods of collecting, etc., and keys to the families. The problems of higher classification and phylogeny are considered rather briefly, the authors being evidently sceptical about any work in this field since Ganglbauer, whose classification in large measure they adopt. Coleopterous larvae receive very summary treatment, about a page and a half of text and no figures being devoted to them—whereas the internal anatomy of adult beetles receives fully 5 pages of text and 8 figures; does this imply that German coleopterists are more likely to dissect their insects than to rear them?

The volume has no bibliography, and the references in the text are overwhelmingly to German authors; such 'nationalism', comparable to that for which British entomologists have been (justly) reproached, is a little surprising in the heart of the 'Common Market'. A rising generation of German coleopterists will doubtless find this volume useful, but will gain the impression, surely mistaken, that only German authors have contributed anything of note to knowledge of European beetles. There are 8 coloured photographic plates (unindexed), mostly very beautiful, in which 16 species are represented; the ten plates of line drawings are designed to illustrate the key to families, which they do fairly adequately.

The family keys are the most original part of the volume, and seem likely to prove useful. No attempt is made to distinguish natural groupings (other than Adephaga) above the family level, and the sequences in the keys are designed purely to facilitate determination. From a cursory survey it seems that most British beetles could be traced fairly easily to their appropriate families in this volume, though I think difficulties might be experienced with some. The uninitiated might well trace certain Cleridae (Enopliinae, Corynetinae) to section 2C, and Scaphidiidae or *Monotoma* to section 2A; the Pythidae do not normally have closed front coxal cavities. Some difficulties may arise from the use of the number of visible abdominal sternites as a leading character, this being often doubtful in practice. The present reviewer is in a position to assure the authors that the tarsi in *Sphaerius* really are 3-segmented (though this can hardly be seen without a cleared preparation and a high magnification), and that *Georyssus* has 5-segmented tarsi with the basal segment very small.

The work will of course be judged mainly on the volumes still to come, which are likely to be more useful to the average British coleopterist than the present one. However, the German-speaking beginner will undoubtedly benefit greatly from the present volume.—R. A. Crowson.