# Observations on biology in the genus *Caryedon* Schönherr (Coleoptera : Bruchidae) in Northern Nigeria, with a list of associated parasitic Hymenoptera

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## Synopsis

Observations on the biology of the eleven species of *Caryedon* found in Northern Nigeria are recorded. A list of the parasitic Hymenoptera associated with *Caryedon* infestations is included.

## Introduction

Eleven species of *Caryedon* Schönherr have been recorded from Northern Nigeria (Prevett, 1965) and information on the life history of only one of these, *C. gonagra* (Fabricius), is available (Davey, 1958). The present work is a summary of observations made whilst collecting adult and larval material and does not, therefore, claim to give a complete picture of the biology of these species. Rather, it is hoped that the observations recorded will stimulate further detailed study of their life history and behaviour.

Biologically, the species of *Caryedon* that are known to occur in Northern Nigeria fall naturally into two groups:

(1) *Larval emergence from fruit of host plant.*—The mature larva emerges from the seed and normally leaves the fruit (a leguminous pod) to construct a cocoon at or below ground level, as observed by Skaife (1926) in *Pachymerus interstinctus* Fähraeus. The redifferentiation of legs in the final larval instar in these species (Prevett, 1953, 1962) is unique in the Bruchidae and is clearly correlated with the habit of larval emergence (*see* Plate I, *A*, *C*).

(2) *Adult emergence from fruit of host plant.*—The mature larva constructs its cocoon within the fruit (single-seeded, four-winged fruits of various species of *Combretum* (Combretaceae)), from which the adult beetle subsequently emerges (*see* Plate II, *A*, *B*). The legs of the final instar larvae are vestigial in such species.

In all 11 species the egg is semi-ovoid, adhering to the fruit by the flat side, through which entry to the seed is effected (unless an indication is here given to the contrary, eggs are always deposited singly). The incubation period is normally within the range five to nine days. Laboratory observations on life history were not carried out under controlled conditions of temperature and relative humidity. Host plant data have been recorded elsewhere (Prevett, 1965).

## Species Emerging from Fruit as Larvae

### *Caryedon gonagra* (Fabricius)

Data on the life history of this species have been summarised by Davey (1958): she states, with reference to the infestation of groundnuts, that the mature larva makes a hole 2–3 mm. in diameter in the shell, and the paper-like pupal case blocks or protrudes from the hole; or the larva may leave the nut and pupate in a case stuck to the outside. In only one out of 408 examples observed in Nigeria, however, was the cocoon constructed within a pod; in all other instances the larva emerged completely through a hole 1–1·5 mm. in diameter (approximately the width of the head capsule). It would appear, therefore, that the larger hole is prepared only when the cocoon is to be constructed partially within the pod, and that this habit is peculiar to the infestation of groundnuts in storage containers.

Larvae of *Caryedon gonagra* are deep pink when they leave the pods of the primary host plants *Tamarindus indica* Linn., *Piliostigma reticulatum* (DC.) and *P. thonningi* (Schum), but this colour disappears after the cocoon has been constructed. Adults are sexually mature on emergence from the cocoon, mating taking place fairly soon afterwards, and egg-laying commencing (usually only upon dry or nearly dry pods) one day later. Breeding is continuous throughout the year in Northern Nigeria, sufficient dry pods of the primary host plants remaining on the trees until new pods are ripe.

It is of interest here to compare observations on this species from Lyallpur, Pakistan (Sohi, 1940), where *C. gonagra* attacks pods of tamarind and is said to hibernate during the winter "probably in the adult as well as in the larval stage", and from Japan (Harada, 1940), where similar observations were made after the importation from Hawaii of infested seeds of *Cassia fistula*.

### *Caryedon cassiae* (Gyllenhal) (Plate I, *A*)

Mature larvae, similar in colour to those of *C. gonagra*, emerge from pods (usually during the afternoon, when temperatures are high) 19 to 28 days after the initial entry, and construct their cocoons normally within one day. The cocoon is sufficiently transparent to allow pupation to be observed, and this was seen to take place 9 to 10 days later. The pupal period varies from 10 to 13 days, and adult beetles remain within the cocoon for a period of 11 to 45 days (mean 28) before emerging. The period from eclosion to adult emergence from the cocoon varied from 57 to 94 days (mean of 44 observations, 73 days).

Although breeding was continuous in the laboratory, it seems possible that in the field the yearly life cycle may include a period of reproductive inactivity, as dry pods of the primary host plant, *Cassia sieberiana* (DC.), were found only from November to May.

### *Caryedon* sp. nr. *pallidus* (Olivier)

Eggs are laid upon the green pods of *Cassia obtusifolia* Linn. from late July until December, by which time most pods have dried. Breeding continues throughout the year upon dry pods, sufficient intact or partially dehisced pods persisting through the dry and wet seasons. The developmental period from egg to adult in dry seeds varies from 8 to 12 weeks, so that in practice it is not necessary for dry pods to persist for as long as this. Mature larvae emerging from green and dry pods are white and deep yellow-orange, respectively. In only a very few instances was cocoon construction observed to take place within the pod.

The results of regular collections of beetles at a 60-watt bulb on the veranda of a house at Kano are summarised in figure 1, *A*.

### *Caryedon albonotatum* (Pic) (Plate I, *B*, *C*)

The pods of *Acacia nilotica*, the primary host plant, reach their full size in October, shortly after the end of the rainy season, although they are still green and the seeds are immature. Adults of *C. albonotatum* were collected in the field by beating foliage and by the operation of a mercury vapour light-trap, only during the period August to early November (fig. 1, *B*). Eggs are laid during October, slightly to one side of the septum of the pod, and each egg is completely covered with black faecal material (Plate I, *B*). Females collected in the field were always found on dissection to have the hind gut full, although the nature of their food was not discovered. At this time the immature seeds of *A. nilotica* are surrounded by a gummy fluid, which would present a considerable hazard to a Bruchid larva entering the pod. By December the seeds have enlarged so that, although there is still fluid at the sides of the pod, there is probably little danger to a larva boring straight through to a seed from the region of the septum. Hatching of the eggs and entry of larvae into the pod does not, in fact, take place until December, embryonic development being followed by a

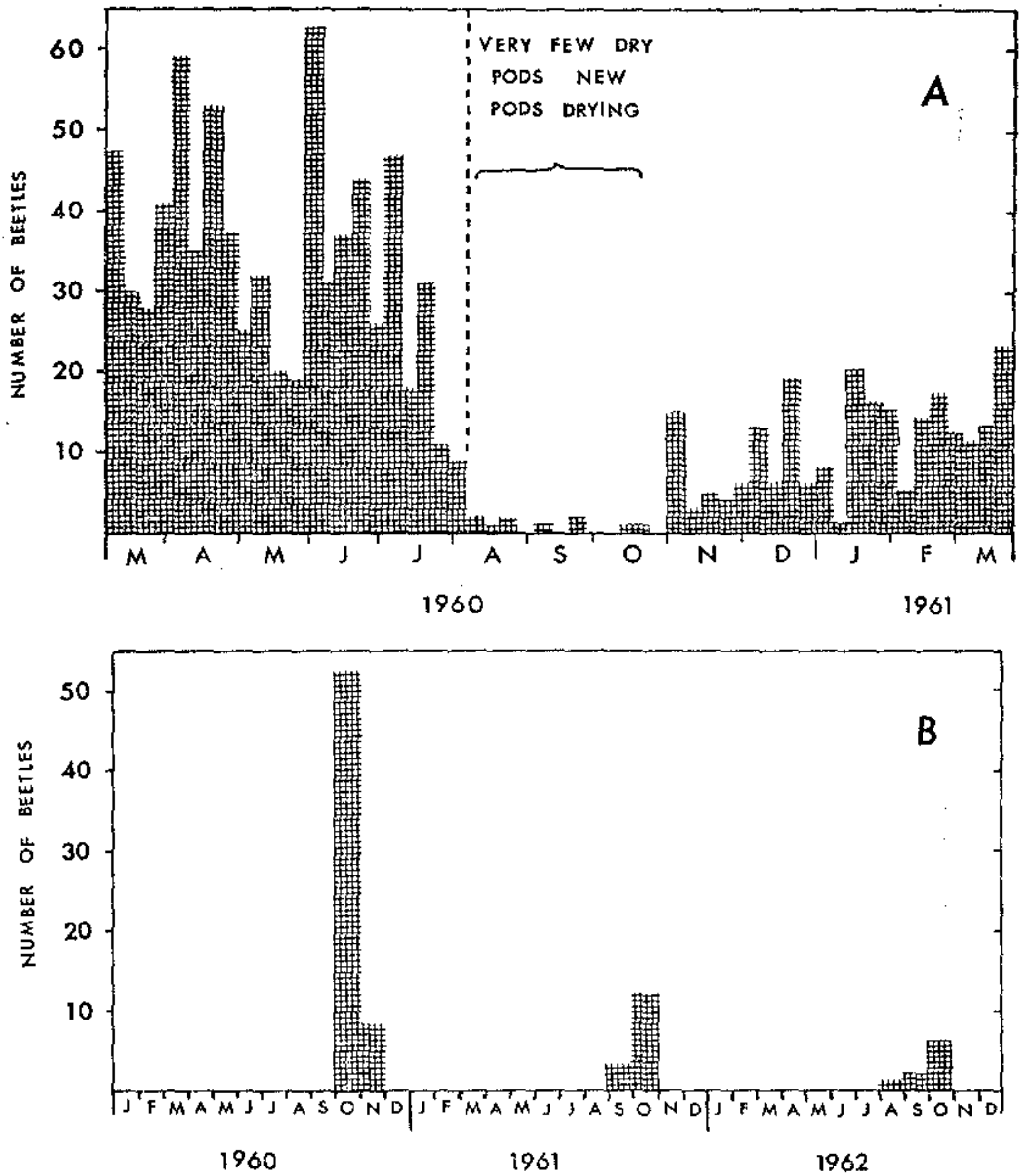


FIG. 1.—(*A*) *Caryedon* sp. nr. *pallidus* (Olivier), weekly totals of beetles collected at light at Kano; the vertical dotted line represents a change of location to an area 2 miles distant, where the primary host plant, *Cassia obtusifolia*, was less abundant. (*B*) *Caryedon albonotatum* (Pic), monthly totals of beetles collected at light and by beating foliage; the exceptionally high number for October 1960 was the result of the operation of a light trap in an area where *Acacia nilotica* was abundant.

period of quiescence. It would appear that this is in some way related to the physiological state of the pod (possibly the state of dryness of the region of the septum that underlies the eggs), and that the eggs are covered to afford protection against such climatic factors as strong sunlight and low relative humidity. This covering appears also to give protection against parasitism by Trichogrammatidae; although there was some mortality as a result of predation in a large number of eggs examined, no evidence of parasitism was found. It is of interest here to note that Teran (1963) records the protection of the eggs of *Caryedes germaini* (Pic) by two "hyaline covers", although he does not discuss the significance of this unusual habit.

Emergence of mature larvae of *C. albonotatum* (Plate I,*C*) takes place during January and February, when the pods have dried. Larvae were found at a depth of two inches in the soil beneath trees of *A. nilotica*. Although a detailed investigation of the site was not made, the fact that no cocoons were found at this level suggests that they are made deeper in the soil, where conditions are moister. Pupation is then delayed by a period of larval diapause of about four months' duration, emergence commencing in August. Large numbers of larvae were kept under observation in the laboratory, and diapause occurred in every individual. The life cycle is, therefore, univoltine with an obligate diapause at the end of the final larval instar, which ensures that adults emerge a few weeks before fully-formed pods of the host plants are available. Egg rudiments can be discerned in the ovarioles of newly emerged females, but the fat body is minute so that feeding is necessary before oviposition can begin.

A high level of infestation of pods of *A. nilotica* was recorded in the vicinity of Kano during January and February, 1962, a total of 2677 mature larvae emerging from 5503 seeds. One sample of 400 seeds, from which 222 larvae emerged, was considered in some detail. The eggs were removed after having been counted, and the number of larval entry holes were also counted. Egg mortality was found to be 7·6 per cent., 528 eggs having hatched out of a total of 571. The greater part of the overall mortality of 61 per cent. occurred, therefore, during the larval stage, and was probably largely due to the fact that in many instances two or three eggs had been laid in a single seed. No parasites were recorded.

Reference is made by Davey (*t.c.* : 395–6) to a private communication from Dr. R. W. Howe regarding the emergence of hundreds of larvae of *C. gonagra* from a stack of *Cassia* pods awaiting use in tanning at Kano; Howe (1952) had previously recorded this species (under the name *C. fuscus*) from seeds of *Acacia arabica* stored at Kano, where the pods are used in tanning. It is considered that both of these records refer to the emergence of larvae of *C. albonotatum* from the pods of *A. nilotica* (closely related to *A. arabica* and used extensively in Northern Nigeria for tanning).

## Species Emerging from Fruit as Adults

### *Caryedon combreti* Prevett (Plate II, *A*, *B*)

### *Caryedon immaculatum* Prevett

Records of emergence from the fruits of *Combretum micranthum* G. Don, collected at regular intervals at the Mariri Forest Reserve near Kano, established that these two species breed throughout the year, although the populations are reduced to low levels during the period following the rainy season, when very few old dry fruits remain and new fruits are in the process of drying.

Pupation takes place within a cocoon prepared inside the fruit (Plate II, *B*). It is constructed in a similar manner to that of *Caryedon fuliginosum*, described below.

### *Caryedon fuliginosum* Prevett

Field data relating to the yearly life cycle of this and the remaining species are sketchy, because they were restricted to localities only visited occasionally. However, observations made in the laboratory suggested that the cycle in this species is probably similar to that described above.

Normally only one larva (occasionally two) develops to maturity within a single *Combretum* fruit, and the cocoon is constructed adjacent to the fragments of seed that remain. One end is attached to the pericarp, and the edge of the circular area so enclosed, through which the adult will emerge, is partially eaten away. The larva then retreats into the cocoon and encloses itself completely by building a partition wall of cocoon material (fig. 2).

*Caryedon lunatum* Prevett
*Caryedon atrohumerale* Prevett
*Caryedon conformis* (Fähraeus)

These species also continued to breed upon dry *Combretum* fruits in the laboratory, suggesting the occurrence of a continuous cycle of generations in the field. The eggs of *C. conformis* were occasionally deposited in pairs.

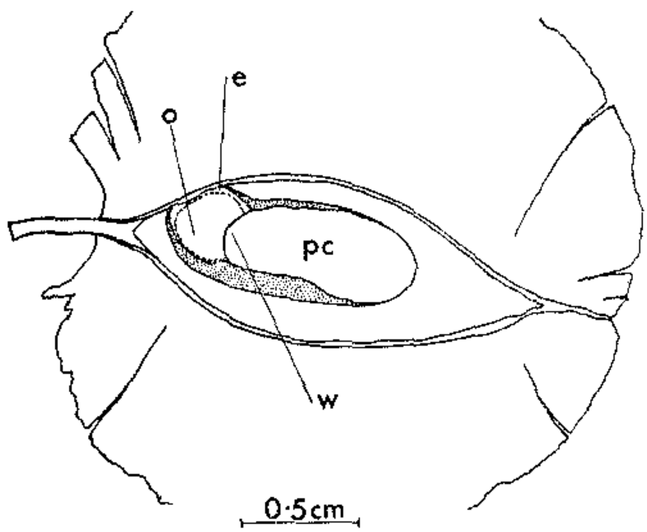


FIG. 2.—*Caryedon fuliginosum* Prevett. Cocoon opened by splitting a *Combretum* fruit; the broken edges of the cocoon are stippled. The circular dotted line (*e*) represents the extent of larval preparation of the edge of the circular area of pericarp (*o*), through which adult emergence takes place. The pupal cell (*pc*) is separated from this area by a wall of cocoon material (*w*).

*Caryedon fasciatum* Prevett (Plate II, *C*)

This species, which was associated with the fruits of *Combretum lamprocarpum* Diels in a single very restricted locality (only two trees were located, within a few yards of each other), was observed always to lay its eggs in groups of three or four. The first egg laid is covered completely by a further three, or occasionally two, eggs (fig. 3). In the field the latter were, without exception, attacked by Trichogrammatid parasites (Plate II, *C*), whereas the lower egg hatched in the normal manner.

Grouping of eggs has been reported in the literature in a few instances, but never according to such a uniform pattern as that found in *C. fasciatum*. Bondar (1937) states that eggs may be laid in groups in a number of species, and Kunhi Kannan (1923) refers to the habit, in *Bruchus amicus* Horn and *B. pisorum* L., of superimposing eggs on top of others, but the only explanation offered is that this is probably due to overcrowding. *Caryedon fasciatum*, however, did not vary in its oviposition behaviour even when beetles were isolated in the laboratory. The incubation period in this species is not prolonged as in *C. albonotatum*, so that there is no reason to suppose that one egg is covered in order to protect it against climatic factors. Rather, one is led to the conclusion that the species has, through natural selection favouring those individuals that happened to conceal a proportion of their eggs in the manner described, become adapted to an environment in which parasitism of exposed eggs appears inevitable. It should be noted, however, that *C. conformis* and *C. atrohumerale*, which do not lay their eggs in this manner, were breeding satisfactorily in the seeds of the same *Combretum* trees. The eggs of *C. fasciatum* are larger than those of the other two species, each supporting two or three parasites, so that it is possible that host eggs are selected for size by the parasite.

Eggs were found upon fully-formed green fruits in July and again upon dry fruits in December. Subsequent generations were reared upon dry fruits in the laboratory.

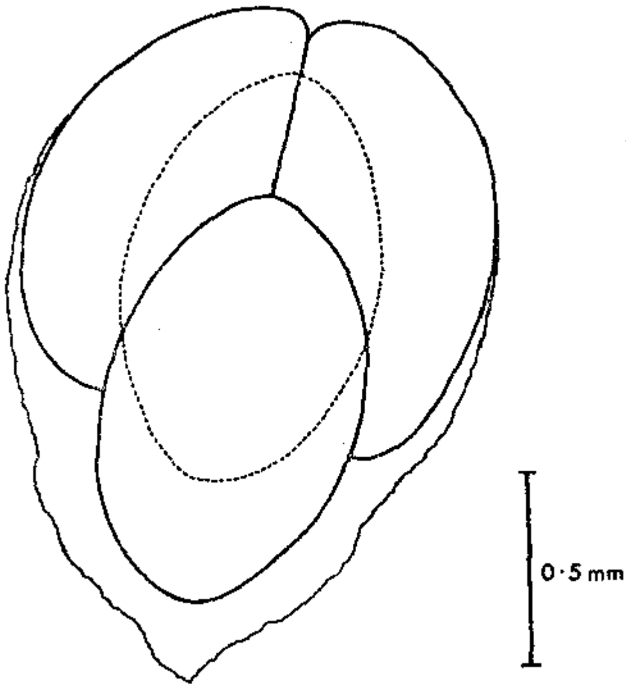


FIG. 3.—*Caryedon fasciatum* Prevett. Typical appearance of group of eggs; the lower egg is shown dotted.

### PARASITIC HYMENOPTERA ASSOCIATED WITH SPECIES OF *Caryedon*

The following species of parasitic Hymenoptera were found to be associated with Bruchid infestations:

BRACONIDAE

(1) *Bracon kirkpatricki* Wilkinson
(2) *Bracon* sp. ?*kirkpatricki* (darker colouring and female with second suture of gaster less sinuate than in *kirkpatricki*)
(3) *Phanerotoma* sp.

EUPELMIDAE

(4) *Bruchocida vuilleti* Crawford

TORYMIDAE (MONODONTOMERINAE)

(5) ?*Microdontomerus* sp.

PTEROMALIDAE

(6) *Paradinarmus* sp.

EURYTOMIDAE

(7) *Eurytoma* sp. nr. *promecothecae* Ferrière (an Indian species)

EULOPHIDAE

(8) *Pedobius* sp.
(9) *Entedon* sp. 1
(10) *Entedon* sp. 2

TRICHOGRAMMATIDAE

(11) *Uscana* spp.[1]

It was, unfortunately, not possible to devote any time to a study of the status or exact host-association of these species, but details are given in Table I below of *Caryedon* and parasite species (indicated by number) emerging from individual samples of pods or seeds.

TABLE I.—*Records of parasitic Hymenoptera associated with* Caryedon *species*

| Host Plant | *Caryedon* species | Parasite species |
|---|---|---|
| *Tamarindus indica* | *gonagra* | 1 |
| *Piliostigma reticulatum* | *gonagra* | 1, 10 |
| *P. thonningi* | *gonagra* | 2 |
| *Combretum glutinosum* | *fuliginosum* | 3, 7, 9* |
| | *combreti* | 4, 6, 8 |
| | *combreti + fuliginosum* | 4, 6 |
| | *fuliginosum* | 4, 6, 7 |
| | *fuliginosum* | 6, 7, 9* |
| *C. molle* | *combreti* | 4, 6 |
| | *combreti* | 4, 6, 7 |
| | *fuliginosum* | 1, 4, 7 |
| *C. micranthum* | *immaculatum + combreti* | 4, 5, 9* |
| | *immaculatum + combreti* | 4, 6 |
| *C. hypopilinum* | *atrohumerale* | 4 |
| | *atrohumerale* | 4, 6, 7 |
| *C. lamprocarpum* | *conformis + fasciatum + atrohumerale* | 6†, 7 |
| | *combreti + atrohumerale* | 9* |

* A large number of parasites develop within a single *Caryedon* larva. The following numbers emerged from individual *Caryedon* cocoons: 19, 24, 25, 26, 40 and 49.

† Thirteen parasites emerged from a single *Caryedon* cocoon.

## SUMMARY

The eleven species of *Caryedon* Schönherr found in Northern Nigeria fall naturally into two biological groups, those that emerge from the fruits as mature larvae and those that emerge as adults.

The life cycle of two species present rather unusual features: in *C. albonotatum* the cycle is univoltine with an obligate diapause at the end of the final larval instar, and in *C. fasciatum* the eggs are always laid in groups, the first egg being covered with two or three further eggs, which are, without exception, attacked by Trichogrammatidae in the field, whereas the first egg hatches normally.

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I should like to record my thanks to Mrs. J. A. J. Clark of the British Museum (Natural History), for the determination of parasitic Hymenoptera, and to the Photographic Department, Pest Infestation Laboratory, Agricultural Research Council, for assistance in preparing the illustrations for this paper. The photograph which appears as Plate II, *C* was taken by Mr. J. Hammond of that Department.

This work was carried out under the auspices of the Nigerian Stored Products Research Institute, Federal Ministry of Commerce and Industry, Nigeria, and is published with the permission of the Ministry of Overseas Development.

[1] One or more species, new to science (Dr. J. Ghesquière, *personal communication*), associated with the eggs of *C. fasciatum* and *C.* sp. nr. *pallidus*, and eggs of *Caryedon* (*gonagra* or *cassiae* or both) on pods of *Cassia sieberiana*.

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### PLATE I

Fig. A.—*Caryedon cassiae* (Gyllenhal): part of a pod of *Cassia sieberiana*, showing eggs and a larval emergence hole.

Fig. B.—*Caryedon albonotatum* (Pic) : part of a pod of *Acacia nilotica*, showing eggs covered with faecal material, situated along the septum (*see* p. 10).

Fig. C.—*Caryedon albonotatum* (Pic): close-up of a pod of *Acacia nilotica*, showing an egg and an emerging mature larva; the larva is almost free from the pod and is moving to the right. The meso- and metathoracic legs can just be distinguished in this photograph.

### PLATE II

Fig. A.—*Caryedon combreti* Prevett: fruit of *Combretum micranthum*, showing egg and adult emergence hole. (*NB.* compare relative size of egg and hole with those in Plate I, A.)

Fig. B.—*Caryedon combreti* Prevett: fruit of *Combretum micranthum* opened to show pre-pupa in cocoon (*see* p. 12). The space to the left of the cocoon is normally filled with uneaten seed fragments and larval frass, but these become dislodged when a fruit is opened.

Fig. C.—*Caryedon fasciatum* Prevett: group of eggs (*see* fig. 3) showing emergence holes of Trichogrammatid egg parasites. The eggs are situated upon a fruit of *Combretum lamprocarpum*, and adjacent to them is the emergence hole of the adult beetle that developed from the egg beneath those parasitised (*see* p. 13).

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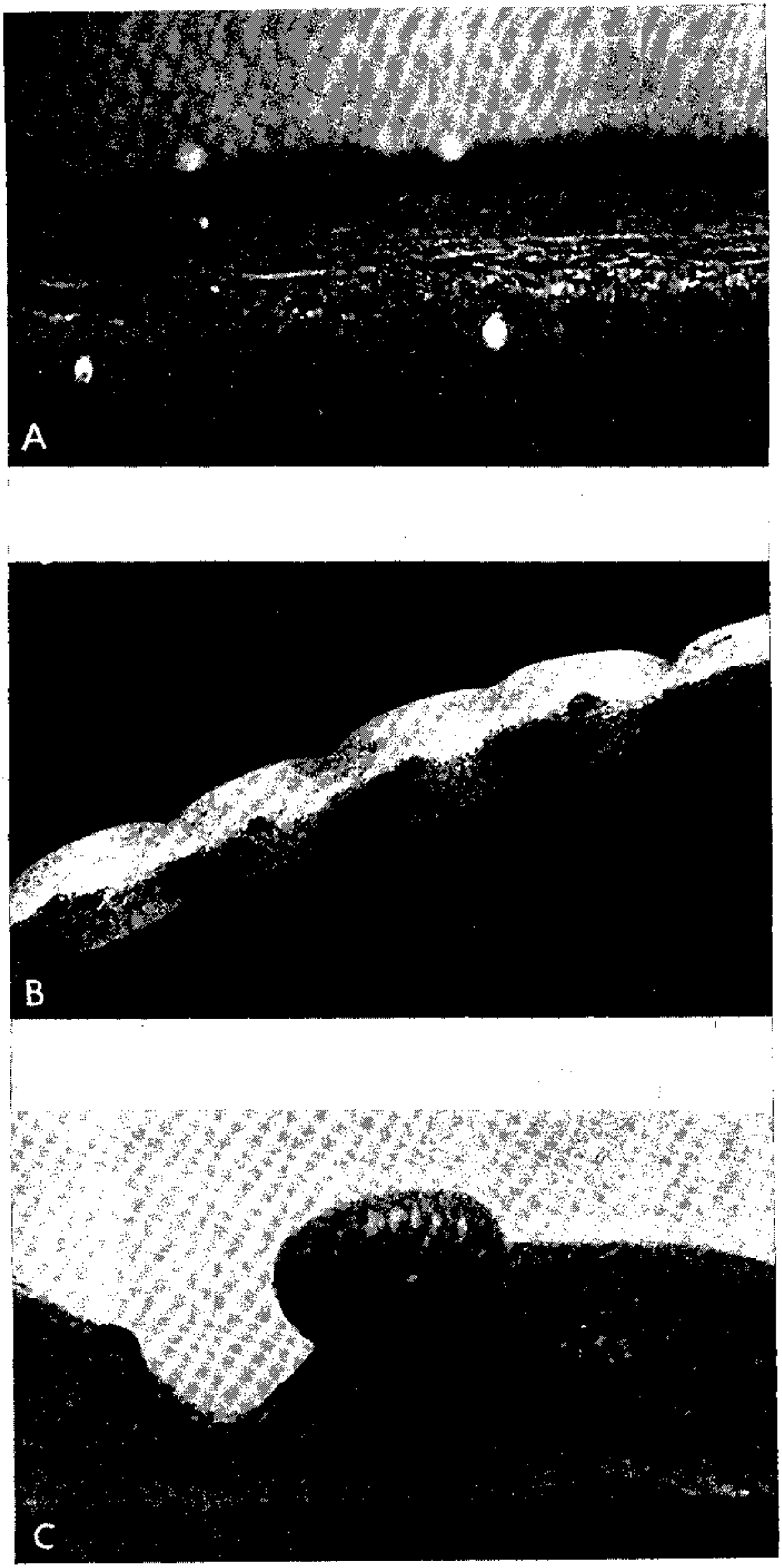
## Book Notice

*Analytical methods for pesticides, plant growth regulators, and food additives. Vol. II. Insecticides.* Edited by Gunter Zweig. 8vo. N.Y. & London: Academic Press, 1964. Pp. xvii, 619, text-illust. £8 4*s*. 6*d*.

This volume, the second in a series of four, provides an authoritative source of information on the analysis of the 47 chemicals included within its scope. These are all widely used insecticides (the term also covers acaricides and other materials), although arsenic has been omitted as the analytical procedures are well known. For each one, detailed analytical procedures are described, as well as its history and biological, chemical and physical properties.

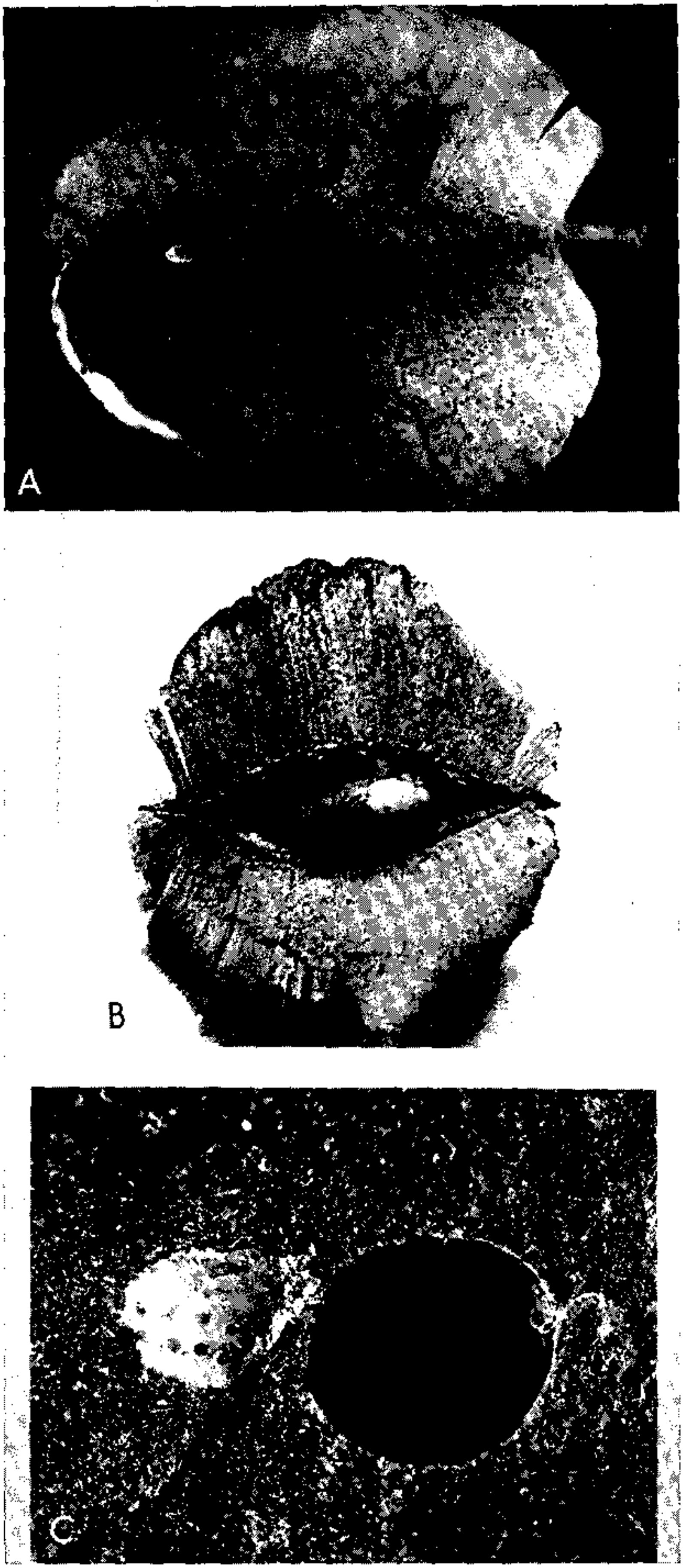
Among the topics covered are two methods of analysis of Thiodan by gas-liquid chromatography, and the problem of finding a specific method for the final identification of residues. The application of gas-liquid chromatography to other chlorinated compounds is described in detail in Volume I of the series.

The arrangement of the work is alphabetical and there is a brief list of references at the end of each chapter. Author and subject indexes conclude the volume.



*Caryedon* spp.

*P. F. Prevett*




*Caryedon* spp.

*P. F. Prevett*