

OBSERVATIONS ON THE COCONUT SPATHE BUG *AXIAGASTUS CAMBELLI* DISTANT (HEMIPTERA: PENTATOMIDAE) AND ITS PARASITES AND PREDATORS IN PAPUA NEW GUINEA

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ABSTRACT

The coconut spathe bug *Axiagastus cambelli* Dist. (Hemiptera: Pentatomidae) is widely distributed throughout the Bismarck Archipelago, Bougainville and the Admiralty Islands in Papua New Guinea but attains economic significance only in restricted areas of its distribution.

Under laboratory conditions at Keravat adult *A. cambelli* lived for up to 48 days. Females deposited up to 23 eggs over a period of 23 days post-copulation.

The effects of intense feeding by adults and nymphs on coconut inflorescences are described in detail.

No important alternate host plants were discovered during the course of these investigations.

The beneficial effect of the kurukum ant *Oecophylla smaragdina* (F.) previously reported on by many authors was confirmed. The situation with respect to the crazy ant *Anoplolepis longipes* Jerd. was in direct contrast. *A. longipes* was frequently observed on palms with high density *A. cambelli* populations.

Parasite surveys carried out throughout the Bismarck Archipelago revealed that the most important egg parasite was the scelionid *Trissolcus painei* Ferriere which attacked 39.1 per cent of all eggs examined. This species was present in all areas surveyed. *Anastatus* sp. (Eupelmidae) was less important, attacking 5.1 per cent of eggs examined.

Tachinid parasites were important bio-control agents in all areas except the Libir Island group. *Pentatomophaga bicincta* de Meij. attacked 12.4 per cent of adults in New Britain. In New Ireland 10.5 per cent of adults were attacked by an unidentified tachnid whilst on Bougainville 4.8 per cent of adults were attacked by *Trichopoda pennipes* F. Tachinid parasites were not recorded from the Libir Group.

A strepsipteron parasite was recorded from all areas and its infestation rate ranged from 1.7 per cent on Libir Island to 4.8 per cent of adults from New Britain.

Other predators and parasites are briefly discussed.

Introductions of the tachnid *P. bicincta* were made into the Libir group from New Britain, but to date no recoveries have been reported.

The fungus *Aspergillus ochraceus* Wilbelm was isolated from adults of *A. cambelli* and also from pupae of the tachnid *Pentatomophaga bicincta*.

INTRODUCTION

THE coconut spathe bug *Axiagastus cambelli* Distant (Hemiptera: Pentatomidae) is widely distributed throughout the Bismarck Archipelago, Bougainville and the Admiralty

Islands in Papua New Guinea but attains economic significance only in restricted areas of its distribution. *A. cambelli* has been found associated with poor bearing conditions of coconuts by many authors but the type of damage and economic significance has not been well documented (Froggatt 1911, Simmonds 1924, Tothill 1929, Lever 1933a, 1933b, Dwyer 1937, Tercinier *et al.* 1964, Cochereau 1965, Lever 1969, Baloch 1973).

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LIFE HISTORY

The life history of *A. cambelli* has been well documented (Tothill 1928, Lever 1933). The eggs are deposited in the crown of palms usually in rafts containing 14 eggs (Baloch 1973). On hatching, the gregarious first instar nymphs do not feed but remain congregated around the egg raft. Second and subsequent instars feed on the young spathes and flowers, as do the adults.

Under laboratory conditions at Keravat, field collected *A. cambelli* adults lived for from two to four weeks. The maximum longevity recorded for a male and female was 48 and 36 days respectively. It was noted that copulation commenced in the early morning and continued for several hours if the mating pairs were not disturbed. In one cage a mating pair remained in copulo for at least 34 hours before separating. Oviposition occurred one to eleven (mean, six) days after commencement of copulation. In the laboratory, mated females deposited one or two egg rafts. The maximum number of eggs laid was 23 in two rafts of 14 and nine eggs respectively. The two rafts were laid 11 and 23 days post commencement of copulation.

Newly moulted adults were caged in the laboratory with sections of young coconut inflorescences, but as previously reported (Baloch 1973) no mating or oviposition took place. It could be that adults require a period of flight activity before mating and oviposition take place.

The life history can be briefly summarised as follows:—

Stage	Duration (Days)
Egg	7 (Lever 1933b) 6 to 8 (Baloch 1973)
1st instar	4 (Lever 1933b)
2nd instar	7 (Lever 1933b)
3rd instar	6 (Lever 1933b)
4th instar	7 (Lever 1933b)
5th instar	10 (Lever 1933b)
Preoviposition	6
Adult	48

DAMAGE

First instar nymphs are gregarious. They remain around the empty egg shells and do not feed. Second and subsequent instars move onto the inflorescence and commence to feed. Adults and late instar nymphs puncture the spathes with their stylets and feed on the peripheral portions of the compacted spadix.

Damage to spathes was studied in some detail on Lihir Island at intervals during the period November 1968 to March 1969.

In general, populations of *A. cambelli* were much higher on the Lihir group than those observed on the Gazelle Peninsula, and in some areas populations were extremely high with several hundred adults and nymphs per spadix. Whilst damage to the spadix and loss of nut production from attack by high populations of *A. cambelli* occurs it is difficult to ascertain the precise loss in production as a result of such attacks.

At Lakakot Plantation spathes were caged with approximately 200 adults and late instar nymphs and then cut down and examined six days later. The spathes had not at this stage separated and the spadix was still completely encased.

The green spathes of the inflorescence were covered with diffuse brown-black areas, which had become contiguous with the constant feeding by the large number of *A. cambelli*.

These spathes were stripped away to reveal the enclosed spadix.

On the inside of the spathes which are creamy yellow in colour, reddish brown areas of discoloration with a central necrotic spot were observed. These areas were contiguous with the markings on the outside of the spathe. The discoloured areas were up to 10 mm in diameter and where puncture marks were numerous the areas had coalesced.

Areas of the spadix in contact with the spathe showed necrotic areas contiguous with the puncture marks. These areas were pinkish brown in colour and were distributed over rachis, racilli, male flower bracts, calyx and flowers of the female inflorescence. These necrotic puncture marks were only found on the outside portions of the folded spadix which, *in situ*, is in close contact with the spathes. The diffuse spots on the spadix were very numerous.

An inflorescence at a later stage of development (as yet still encased in the spathe) and also attacked by *A. cambelli* showed discoloured areas on both surfaces of the spathe and areas of the spadix in close contact with the spathe.

Most of the calyces of male flowers on the outside of the folded spadix were necrotic and black. Extensive spotting was again observed on the spadix.

Examination of an inflorescence which had opened in the field under sustained *A. cambelli* attack revealed that the racilli were dead from one half to three quarters of their length. Areas of the remaining racilli and rachis were necrotic as a result of puncture marks. Many of the young button nuts were punctured and the attendant necrotic areas were evident internally.

Examination of numerous spadices in different stages of development indicated that prolonged, intense feeding by *A. cambelli* caused premature necrosis of the terminal sections of the racilli. At a later stage the rachis was similarly affected and the young nuts were arrested at an early stage of development. Many "wizened" young nuts were observed on attacked inflorescences. Under sustained, heavy attack, most of the nuts failed to develop beyond five to eight centimetres in diameter, were retained for some considerable time and all finally dropped into the axils of fronds. The attacked inflorescence had a characteristic blackened, dried-up appearance.

Adults were observed in the act of feeding and found to be able to penetrate tissue to a depth of approximately one centimetre. When feeding they were difficult to disturb but when induced to withdraw the proboscis were found to stroke the fore-legs over the proboscis thereby returning the feeding stylets into the sheath.

The area surrounding the puncture mark internally was rather opalescent but gradually turned reddish brown and finally became necrotic.

There was no evidence of a preferred feeding site on the inflorescence. Surface browning around puncture marks occurred within 12 hours after exposure to *A. cambelli*. Similar discolourations were reproduced on sections of coconut inflorescence by puncturing them with a fine entomological pin. There was no conclusive evidence to suggest that insectotoxins were involved and it appeared that polyphenyl oxidase activity at the puncture site and dehydration (Smee 1965) were the most important factors associated with premature necrosis following intense feeding.

Feeding also occurred on older inflorescences but is usually less intense. Nuts over four months appeared to be little affected by *A. cambelli* feeding.

Following a single trunk injection 10 gm of either monocrotophos or dicrotophos, palms previously carrying very heavy populations of *A. cambelli* produced one or two flowers free of feeding punctures, but with the return of high *A. cambelli* populations by 12 weeks post-treatment these inflorescences failed to carry through any nuts (O'Sullivan 1974).

ALTERNATE HOSTS

There is one reported instance of *A. cambelli* being found on the inflorescence of a wild *Areca* sp. palm in the British Solomon Islands Protectorate (Lever 1933b). Egg masses of *A. cambelli* were also found on the leaves of *Casuarina* sp. in the British Solomons (Lever 1932) but Lever considered that the eggs were a chance occurrence on *Casuarina* sp. In the laboratory, adults have fed on fruits of the cluster palm *Ptychosperma* sp. (Baloch 1973).

Intensive search in the Bismark Archipelago of the betel nut palm *Areca catechu* and related *Areca* spp. has not revealed any *A. cambelli* on *Areca* palms even where *Areca* palms were surrounded by coconut palms carrying high numbers of *A. cambelli*. Eighty per cent of field collected adults caged with sections of *A. catechu* inflorescences were still alive after six days, but there was no evidence of deep rostrum penetration of the inflorescence by *A. cambelli*. It is thus apparent that *Areca* spp. are not important host plants of *A. cambelli*.

No other alternate host plants were located during the course of investigations.

INFLUENCE OF ANTS

The beneficial effects of the kurukum ant *Oecophylla smaragdina* (F.) have been reported by many authors. In the British Solomons, *O. smaragdina* was reported to afford almost complete protection from *A. cambelli* attack (Tothill 1929). In the Western Solomons, "good" and "bad" areas of palms were compared and it was found that "good" bearing areas had up to 93 per cent of palms colonised by *O. smaragdina* and few *A. cambelli* whereas in the "poor" bearing areas, *O. smaragdina* were few or absent and up to 100 per cent of palms were colonised by *A. cambelli* (Lever 1933a, 1933b).

On Lihir Island, adult *A. cambelli* were confined in a wire cage with a nest of *O. smaragdina* on a palm spadix. The *A. cambelli* were introduced at night and commenced feeding actively on the palm spadix. *O. smaragdina* remained inactive during the night and did not interfere with feeding by *A. cambelli*. Individuals of the *O. smaragdina* colony commenced activity shortly after sunrise and began to attack the *A. cambelli*. Small groups of *O. smaragdina* immobilized the *A. cambelli* by seizing the legs and antennae. Further arrivals

helped to tear the *A. cambelli* apart and sections of the body were carried off. By evening only a few scattered sections of exoskeleton remained.

The relationship between *A. cambelli* and *O. smaragdina* was also studied in detail in the field at Lihir Island.

Regular counts of *A. cambelli* and *O. smaragdina* populations on 122 marked palms were carried out between July 1970 and January 1972. Results are shown in Table 1.

Table 1.—Number of marked coconut palms occupied by *Oecophylla smaragdina* and *Axiagastus cambelli* at Lihir Island, July, 1970 to January, 1972

Date of Recording	Palms with							
	<i>Oecophylla</i> only		<i>Axiagastus</i> only		Both		Neither	
	No.	%	No.	%	No.	%	No.	%
July 1970	36	29.5	45	36.9	0	—	41	33.6
Aug. 1970	61	50.0	41	33.6	2	1.6	18	14.8
Oct. 1970	66	54.1	38	31.1	6	4.9	12	9.8
Nov. 1970	53	54.4	41	33.6	6	4.9	22	18.0
Dec. 1970	58	47.5	31	25.4	5	4.1	28	23.0
Jan. 1971	48	39.3	30	24.6	2	1.6	42	34.4
Feb. 1971	53	43.4	26	21.3	1	0.8	42	34.4
March 1971	50	41.0	36	29.5	2	1.6	34	27.9
April 1971	57	46.7	27	22.1	2	1.6	36	29.5
May 1971	47	38.5	27	22.1	2	1.6	46	37.7
June 1971	57	46.7	12	9.8	3	2.5	50	41.0
July 1971	46	38.0	18	14.9	1	0.8	56	46.3
Oct. 1971	55	45.5	27	22.3	0	—	39	32.2
Jan. 1972	52	43.0	36	29.7	10	8.3	23	19.0
Total	739	43.3	435	25.5	42	2.5	489	28.7

The infrequent occurrence of both species together on palms confirmed earlier observations by Tothill (1929) and Lever (1933b). Where both species occurred together on palms investigations showed that either one or other of the species occurred in restricted numbers. There was no recorded instance of nests of *O. smaragdina* occurring together with large populations of *A. cambelli* on the same palm.

The situation with respect to the crazy ant *Anoplolepis longipes* Jerd. was a direct contrast. Palms used for systemic insecticide trials in an adjacent block (O'Sullivan 1974) were heavily colonised by *A. longipes*. *O. smaragdina* were completely absent and all palms were carrying very high populations of *A. cambelli*.

Three years observations throughout islands other than Lihir Island in the Bismarck Archipelago support these findings, in that *O.*

smaragdina and *A. cambelli* infrequently occurred together on palms, whereas palms colonised by *A. longipes* invariably supported large populations of *A. cambelli*.

Observations also suggest that in areas where *A. cambelli* populations are capable of attaining high levels, coconuts with fully canopied interplanted mature cacao support lower populations of *A. cambelli* than sole planted stands in equivalent areas.

PARASITES OF AXIAGASTUS CAMBELLI

The distribution of natural enemies of *A. cambelli* on the Gazelle Peninsula of New Britain and observations on their life history have been discussed recently by Baloch (1973).

Further detailed parasite surveys were carried out throughout New Britain, New Ireland, Bougainville and Lihir Island and small

collections from other areas were examined to determine the distribution and relative importance of parasites in the control of *A. cambelli*. These surveys yielded a further three records of parasites, two of them possibly new from *A. cambelli*. The parasites recorded were a strepsipteron (gen. et sp. indet.) which was collected from all areas examined, and two species of tachinids, one from New Ireland

(gen. et sp. indet.), and *Trichopoda pennipes* F. from Bougainville.

T. pennipes has previously been recorded as ovipositing on *A. cambelli* in the British Solomons (O'Connor 1950) but has not previously been bred from *A. cambelli*.

Distribution details of egg parasites are shown in Table 2.

Table 2.—Distribution and relative abundance of *A. cambelli* egg parasites, *Trissolcus painei* and *Anastatus* sp.

Locality	Date	No. <i>A. cambelli</i> eggs examined	Aborted	Parasitised eggs			
				<i>Trissolcus</i> No. %		<i>Anastatus</i> No. %	
Lihir Group	Nov./Dec. 1970	320	Not determined	43	13.4	14	4.4
Bougainville	Nov. 1971	891	22	427	47.9	48	5.4
New Ireland	Dec. 1971	41	Not determined	22	53.7	0	—

The overall rate of parasitism for *Trissolcus painei* Ferr. was 39.1 per cent. The highest individual recording was 70.2 per cent for a large collection of 191 eggs from Hohela, Buka Island. *Anastatus* sp. was bred from 5.4 per cent of eggs collected from Lihir Island and Bougainville, with the highest individual recording of 10 per cent of eggs attacked for a large collection of 400 eggs from Hagan, Buka Island. The highest combined total for the two egg parasites was 59 per cent of eggs at Makela, Buka Island compared to the overall level of 44.2 per cent for all areas. This compares with a report of 64 per cent destruction of eggs on one island in the British Solomons (Lever 1934).

The other known egg parasite *Acroclisoides* sp. ?*megacephalus* Gir. has been bred from eggs collected on the Gazelle Peninsula (Baloch 1973). It has since been bred in the laboratory from eggs collected at Massahet Island, Lihir group, some 26 days after the eggs were collected. It was not bred from any of the 891 eggs collected from eight widely scattered localities on Bougainville. It must be considered to be of very minor importance only.

The braconid nymphal parasite *Aridelus* sp., previously recorded from the Gazelle Peninsula (Baloch 1973) was not recorded from any other localities during the surveys.

Large collections of adults and nymphs of *A. cambelli* were collected from islands in the Bismarck Archipelago and examined for parasites. A strepsipteron (gen. et sp. indet.) parasite of adults was obtained from all areas so far examined. The tachinid parasite *Trichopoda pennipes* was bred from both adults and nymphs collected in Bougainville and another tachinid (gen. et sp. indet.) was bred from *A. cambelli* collected on New Ireland.

Details of collections are shown in Table 3.

It can be seen that tachinids are significant parasites of *A. cambelli* in regions where they are established. Of 1597 adults collected on New Britain 12.4 per cent had been attacked by *Pentatomophaga bicincta* de Meij., with a maximum rate of 15.5 per cent for 232 adults collected at Tavilo, New Britain. Of 952 adults collected on New Ireland 10.5 per cent were attacked by the unidentified tachinid with a maximum rate of 57 per cent of 88 adults

Table 3.—Relative abundance of tachinid and strepsipteron parasites of *Axiagastus cambelli* adults and nymphs

Locality	Date	No. of <i>A. cambelli</i>			No. and per cent with tachinids						No. and per cent with strepsipteron			
		Male ♂	Female ♀	nymph	Male ♂	%	Female ♀	%	nymph	%	Male ♂	%	Female ♀	%
1. NEW BRITAIN														
Gazelle Peninsula	Jan.-April 1971	666	884	46	61	9.2	137	15.5	0	—	21	3.2	50	5.7
Bainings	Mar. 1971	15	14	9	0	—	0	—	0	—	1	6.7	5	35.7
Lolabau Island....	Sept. 1971	5	17	0	0	—	0	—	0	—	0	—	0	—
TOTAL		682	915	55	61	8.9	137	15.0	0	—	22	3.2	55	6.0
2. BOUGAINVILLE														
Buka Island	May-Nov. 1971	476	601	122	23	4.8	38	6.3	5	4.1	4	0.8	13	2.2
North Bougainville	Nov. 1971	76	71	15	0	—	0	—	0	—	2	2.6	3	3.9
East Bougainville	Nov. 1971	156	113	147	3	1.9	3	2.7	4	2.7	5	3.2	2	1.3
S. W. Bougainville	May and Nov. 1971	199	291	145	9	4.5	19	6.5	1	0.7	5	2.5	6	2.1
TOTAL		907	1076	429	35	3.9	60	5.6	10	2.3	16	1.8	24	2.2
3. LIHIR GROUP														
Lihir Island	1970-71	904	1157	286	0	—	0	—	0	—	14	1.5	21	1.8
Massahet Island	Nov. 1970	93	68	0	0	—	0	—	0	—	1	1.1	2	2.9
TOTAL		997	1215	286	0	—	0	—	0	—	15	1.5	23	1.9
4. NEW IRELAND														
N.E. New Ireland	Dec. 1971	211	370	99	15	7.1	57	15.4	0	—	7	3.3	8	2.2
Kavieng West Coast	Dec. 1971	56	90	9	3	5.4	17	18.9	0	—	0	—	2	—
S.W. New Ireland	March and Dec. 1971	97	128	159	3	3.1	5	3.9	0	—	7	7.2	12	9.3
New Hanover Is.	March 1971	24	41	1	0	—	2	4.9	0	—	0	—	0	—
TOTAL		388	629	268	21	5.4	81	12.9	0	—	14	3.6	22	3.5
5. ANIR ISLAND	Aug. 1971	7	12	5	0	—	0	—	0	—	0	—	0	—
6. TANGAR ISLAND	Aug. 1971	20	52	2	0	—	0	—	0	—	0	—	0	—

from Fisova Village. *T. pennipes* attacked 4.8 per cent of 1983 adults examined from Bougainville, with a maximum of 14.4 per cent of 118 adults attacked in a collection from Laguai Village, Bougainville. *T. pennipes* also attacked 2.3 per cent of the nymphs collected on Bougainville.

No tachinid parasites were bred from or tachinid eggs noted on 2212 adults examined from the Lihir group or from smaller collections from Tangar and Anir Islands.

The strepsipteron parasite was isolated from 2.8 per cent of 6900 adults collected from all localities. On New Britain, 4.8 per cent of 1597 adults collected contained the strepsipteron with the highest recording of 8.8 per cent being from an individual collection of 353 adults from Napapar Village. 3.9

per cent of 952 adults collected from New Ireland were attacked by the strepsipteron, with a maximum of 13.9 per cent of 79 adults from Namatanai. 2.0 per cent of 1973 adults collected from Bougainville contained the strepsipteron with the highest individual recording being 5.7 per cent of 140 adults collected at Kessa, Buka Island. At Lihir Island, 1.7 per cent of 2212 adults collected were found to contain the strepsipteron. The highest individual collection was 10.3 per cent of a collection of 78 adults from Louise Harbour.

The strepsipteron was also isolated from a small collection from Anir Island.

The known distribution of the various parasites of *A. cambelli* is summarised in Table 4.

Table 4.—Known distribution of parasites of *A. cambelli* in Papua New Guinea

Stage of Axiagastus attacked	Parasite	Status of Parasites at Various Localities				
		Gazelle Peninsula	Lihir group	New Ireland	New Hanover	Bougainville
Egg	<i>Trissolcus painei</i>	+	+	+	0	+
	<i>Anastatus</i> sp.	+	+	+	0	+
	<i>Acroclisoides ?megacephalus</i>	+	+	+	0	+
Nymph	<i>Aridelus</i> sp.	+	0	0	0	0
Nymph and adult	<i>Pentatomopbaga bicincta</i>	+	—	0	0	0
	<i>Trichopoda pennipes</i>	—	—	—	—	—
	Tachinidae, gen. et sp. indet.	—	—	—	—	+
Adult	Strepsipteron, gen. et sp. indet.	+	+	+	+	—

Key: + = Present

— = Absent

0 = Status not known

INTRODUCTION OF TACHINID PARASITES, LIHIR ISLAND

Introductions of laboratory reared pupae of *P. bicincta* obtained from *A. cambelli* collected from the Gazelle Peninsula were undertaken at three localities on Lihir Island between January and December 1971. The pupae were placed in frond axils of palms which carried high *A. cambelli* populations and were free from the kurukum ant *O. smaragdina*. Releases were made at two plantations at opposite ends of the main island and in native groves at Louise Harbour.

Recovery surveys have been carried out in all areas but at the time of writing (January 1972) no recoveries of *P. bicincta* had been made from any of the release areas.

POSSIBLE FUNGAL PATHOGENS

During the course of these studies, field collected *A. cambelli* adults were held in the laboratory and examined for possible fungal pathogens. Two adults collected from Lihir Island were observed with mycelium growing from between the thoracic sternites. The fungus was subsequently identified by the Commonwealth Mycological Institute as

Aspergillus ochraceus Wilhelm. This fungus has also been isolated from pupae of the tachinid parasite *P. bicincta* on the Gazelle Peninsula.

No pathogenicity tests were carried out to determine whether this fungus was truly pathogenic. However the low frequency of occurrence suggests that the fungus is not of great importance in limiting *A. cambelli* populations.

OTHER PREDATORS

Willy wagtails (*Rhipidura leucophrys melaleuca* (Quoy and Gaimard)) and the common crow (*Corvus orru insularis* Heinroth) have been reported to feed on *A. cambelli* (Szent-Ivany in litt.). At Lihir Island, starlings (*Aplonis cantoroides* (Gray)) and *A. metallicus nitidus* (Gray)) have been observed to pick up *A. cambelli* but where early instar nymphs of the coconut tree hopper *Segestidea insulana* Willemse are present in large numbers, the starlings show an apparent preference for this species. They feed voraciously on the young nymphs on the palm fronds and ignore the *A. cambelli* on the inflorescence.

Two species of unidentified lizards have also been observed to feed on *A. cambelli*, but it is doubtful whether they provide any worthwhile control.

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