Insectes Sociaux, Paris.
1976, Tome *23*, n° 3, pp. 253-262.

THE SEASONAL LIFE CYCLE OF *ANOPLOLEPIS LONGIPES* (JERDON) (HYMENOPTERA : FORMICIDAE) IN A CACAO PLANTATION AND UNDER BRUSHED RAIN FOREST IN THE NORTHERN DISTRICT OF PAPUA NEW GUINEA

By G. L. BAKER

Entomology Branch, Biological and Chemical Research Institute, Department of Agriculture, Rydalmere, N.S.W., 2116, Australia.

Reçu le 1er octobre 1975. Accepté le 22 mars 1976.

SUMMARY

The only period of sexual brood production during the year occurred at the beginning of the wet season. Dispersal of mature sexuals from their colonies of origin took place in the third and fourth months of the wet season. However, dispersal of alate females was not apparent from nests at the cacao site. The worker caste was produced throughout the wet season and reached a peak after the dispersal of mature sexual castes. For the rest of the year they were produced at a reduced level, dependent in part upon the harshness of the dry season.

RÉSUMÉ

Le cycle de vie saisonnier de l'*Anoplolepis longipes* (Jerdon) (Hymenoptera : Formicidae) dans une plantation de cacao établie sous le couvert d'une forêt tropicale clairsemée du district Nord de Papouasie (Nouvelle-Guinée).

Le résultat de cette étude montre qu'il n'y a qu'une seule période d'élevage de sexués au cours de l'année et qu'elle se situe au début de la saison des pluies. Les mâles et femelles ailées, arrivés à maturité, essaiment au cours des 3e et 4e mois de la saison des pluies et sont dispersés loin de leur lieu de naissance. Toutefois, dans la cacaoyère, la dispersion des reproducteurs ne s'est pas faite comme dans la forêt témoin. La

production de la caste ouvrière couvre toute la saison des pluies et atteint un maximum après l'essaimage. Pendant le reste de l'année, la production des ouvrières décroît significativement, le degré de diminution étant fonction de la sécheresse, plus ou moins marquée, de cette saison.

INTRODUCTON

Anoplolepis longipes (Jerdon) is a dominant ant species in some cacao plantings in the Northern District of Papua New Guinea where it is important in the biological control of the cacao weevil borer *Pantorhytes szentivanyi* Marshall (BAKER, 1972). The use of ants to control insect pests in cacao plantations has proven feasible in the Camerouns (BRUNEAU DE MIRÉ, 1969). LESTON (1973) has reviewed the subject of the use of ants in limiting pests of tropical tree crops. ENTWISTLE (1972) gives a general account of the role of *A. longipes* in the entomology of cacao in other cacao producing areas of the world.

Interest is being shown in the establishment of *A. longipes* colonies in cacao plantings in the Northern District of Papua New Guinea to control *P. szentivanyi*. This study was undertaken to examine the seasonal life cycle of *A. longipes* to gain information essential for the development of the successful means of transferring and establishing colonies of the ant.

The climate in the Northern District of Papua New Guinea is a tropical rain forest type (KOPPEN, 1936) characterised by two major seasons; a dry season from May to October with an average monthly rainfall <100 mm associated with south-easterly winds, and a wet season from December to March with an average monthly rainfall >250 mm associated with north-west winds. Copious rains also fall in the transitional months. Temperatures and humidities are high and almost uniform throughout the year. Temperatures rarely exceed 35 °C and seldom fall below 21 °C (SLATYER, 1964).

METHOD

The tropical rain forest site was located on Lejo Plantation in the Northern District. The rain forest had been brushed and partially thinned in preparation for planting of cacao under forest shade. Colonies of *A. longipes* were abundant in the leaf litter zone. *A. longipes* does not construct nests in rain forest but simply utilises natural spaces in the leaf litter. More elaborate nests, including deep ground nests, are however constructed in exposed habitats such as open grassland (BAKER, in preparation).

Three months before sampling began, one hundred bamboo segments were spread throughout the area on a grid pattern of five metre squares. Each bamboo segment consisted of a node and an internode of the stem of *Bambusa vulgaris* L. The stem segments were 6 to 10 cm wide and 45 to 50 cm long. They were closed at one end by the node and open at the other. Previous work (BAKER, unpublished data) has shown that bamboo segments are preferred nesting sites and are quickly colonised

by *A. longipes*. Bamboo poles have been utilised for the collection and eradication of colonies of *A. longipes* from coffee gardens in Indonesia (VAN DER GOOT, 1916). The colonies which establish in the bamboo segments are complete, being the result of a transfer of all brood from surrounding colony fragments into the protective environment provided by the bamboo poles (VAN DER GOOT, 1916). This implies that the composition of the colonies in the bamboo segments is representative of the more fragmented natural colonies not provided with bamboo segments. The only component of the colony which may not be accurately represented at the time of sampling are workers. The proportion of the total population of workers present at the time of sampling is dependent on the amount of foraging activity being undertaken at the time and is therefore subject to variation. From August 1971, seven bamboo segments were collected at random from the sampling area each month. Immediately after collection of each

FIG. 1. — Sampling of an *A. longipes* colony by removing colony from a segment of bamboo previously placed in the field.

FIG. 1. — Echantillonnage d'une colonie de *A. longipes* par récolte de la colonie installée dans un segment de bambou primitivement placé sur le sol.

segment, the contents were emptied into a heavy duty envelope which contained a wad of toilet tissue soaked in chloroform (fig. 1), after which the bamboo segment was placed back in its original position on the forest floor. The use of this sampling technique has meant that the length of time the colony has occupied the bamboo segment is not known. However, this is not an important consideration when it is remembered that the colonies are not newly established in the traditional sense but are simply well established colonies transferred *in toto* to a more favourable nesting site.

At scoring, nine stages were recognised : egg masses; larvae, other than queen larvae; queen larvae; pupae, other than queen pupae; queen pupae; males; alate queens; dealate queens; and workers.

Scoring of egg masses and larvae was done by scanning the sample under a binocular microscope after other stages had been counted and removed. The number of each stage in each of the seven samples was summated for interpretation of trends.

It was found impracticable to separate the colony biomass into stages and weigh them immediately after sampling, so the proportion of each stage of the total biomass was calculated by multiplying the number by the average live weight (Table I).

The cacao plantation study site was located on Block 11, Bisi Plantation in the Northern District, a distance of 0.6 kilometres from the rain forest site at Lejo. Scoring was carried out between June 1970 and August 1971 as part of a trial aimed at inducing

TABLE I. — Average live weight of life-history stages of *A. longipes*.

TABLEAU I. — Poids vivant moyen de *A. longipes* à différents stades d'évolution.

Life-history stage	Average weight of individual (mg)	Sample size
Egg masses	<0.01	40
Larvae (excluding late instar queen larvae)	0.93	500
Pupae (excluding queen pupae)	1.52	1,000
Queen larvae	11.64	210
Queen pupae	23.90	295
Alate Queens	22.46	330
Dealate queens	22.74	140
Males	1.54	250
Workers	2.16	1,000

the spread of *A. longipes* from occupied areas of cacao to adjacent unoccupied areas. In this trial a series of artificial nesting sites, including bamboo segments, had been provided linking the occupied and unoccupied areas. Regular observations were made on the composition of colonies within the bamboo segments located in the area of cacao occupied by *A. longipes*.

The colonies were not removed from the field, the same colonies being scored on each occasion. The composition of the colony was scored by facing the open end of the bamboo segment towards the light and gradually rotating the bamboo while counting the life history stages. Scored were the number of : alate and dealate queens; males; queen larvae; queen pupae; egg masses; worker larvae and worker pupae. Workers in this trial were recorded only as present or absent. This scoring activity did not unduly disrupt the colony; queens remained stationary and workers would conveniently pick up larvae, pupae and egg masses in their mandibles and raise then in the air while also remaining stationary. Queen pupae and queen larvae were easily recognised because of their large size. Because males are similar in size and colouration to workers they were possibly overlooked in some instances. Because of the rapid counting technique, the number of egg masses, worker larvae and worker pupae are only approximate values.

RESULTS

Seasonal production of sexual brood.

The results from both sampling sites (fig. 2 and 3) show that there was only one period during the year when the production of sexual brood took place. Alate females were however found during most of the year at the cacao site.

After the period of non production of sexual brood, queen larvae were first recorded at the cacao site in late August 1970; at the rain forest site in September 1971 and again in December 1972 (no sampling was carried out in November 1971).

The time of the onset of sexual brood production corresponds closely in all years to the first wet month following the mid-year dry season. In 1970

the wet season began in August; in 1971 it began in September; and in 1972 there was a severe drought throughout Papua New Guinea and the wet season did not begin in the Northern District until November (fig. 2 and 3).

Males were present in samples taken from the rain forest site between October and December 1971 and again in December 1972 (fig. 2). When males first appeared in October 1971 very few alate queens were present. The sharp

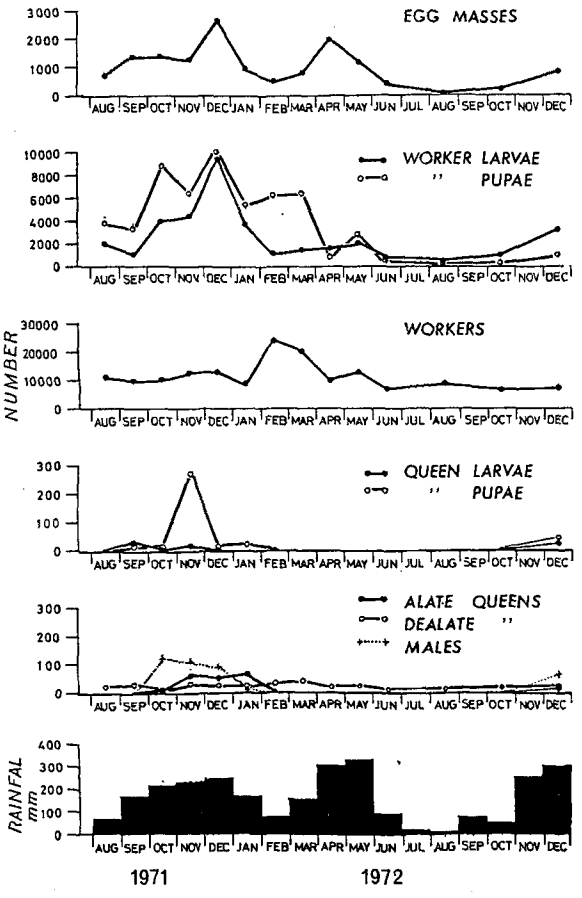

FIG. 2. — Seasonal changes in the composition of *A. longipes* colonies sampled from under thinned rain forest.

FIG. 2. — Changements saisonniers dans la composition des colonies de *A. longipes* échantillonnées sous un couvert forestier clairsemé.

decline in the number of males between December 1971 and January 1972 indicates that dispersal from their nests took place over this period.

At the cacao plantation site (fig. 3), males were not observed until some six weeks after alate females appeared. There was an increase in the number of dealate queens starting in October, the month when alate queens first appeared, and presumably undetected males had been present. No males were recorded after December 1970. There was a gradual dispersal of alate queens from their colony of origin at the cacao plantation site indicated by the absence of

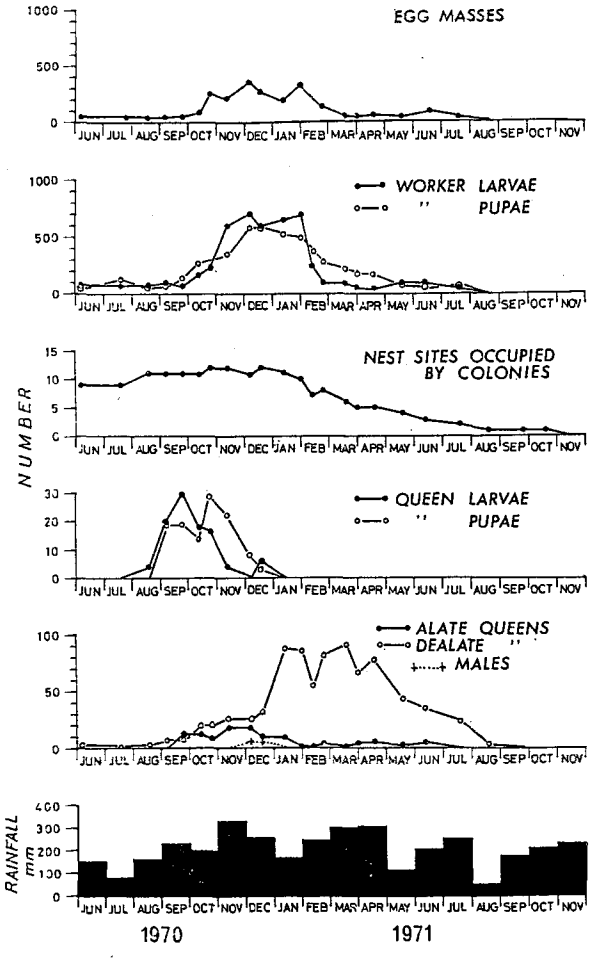

FIG. 3. — Seasonal changes in the composition of *A. longipes* colonies under plantation grown cacao.

FIG. 3. — Changements saisonniers dans la composition des colonies de *A. longipes* échantillonnées dans une cacaoyère.

a sharp fall in numbers. The incidence of dealate queens reached a high level in nests in January 1971 (fig. 3), indicating that recruitment of dealate queens by the colonies under observation had taken place.

Seasonal production of worker brood.

At the rain forest site, the number of worker larvae increased between October 1971 and January 1972 (fig. 2). This indicates that worker brood production was occurring at the same time as sexual brood production. The production of sexual brood ceased in November 1971, however worker brood continued to be produced in ever increasing numbers until March 1972 due to the continued occupancy of the colonies by the new generation of deleate

queens. The number of workers in samples consequently increased in February 1972 and continued to increase until May 1972. There was relatively little further production of worker brood until the onset of the sexual brood period at the beginning of the wet season in November-December 1972.

Seasonal changes in colony biomass.

The biomass of colonies (Table II), varied considerably during the trial period. Before the onset of the sexual brood production period, the total biomass was about 30 g, the worker population comprising 74 per cent of the total biomass. During the sexual brood production period the biomass doubled. This increase in biomass was due to the initiation of sexual brood production, followed later by an increase in production of worker brood. The worker component of the total biomass declined to as low as 48 per cent during this sexual brood production period.

With the decline in the production of sexual brood in November 1971, and the decline in worker caste production in March 1972, the worker component of the total biomass rose to reach 94 per cent by June and remained at this level until the onset of the sexual brood production period in December 1972. The proportion of the total biomass composed of dealate queens was relatively constant throughout the sampling period (Table II).

TABLE II. — Life-history stages of *A. longipes* as a proportion of the total biomass of seven colonies from under forest at the Lejo site.

TABLEAU II. — Différents stades d'évolution de *A. longipes* évalués en rapport de la biomasse totale de 7 colonies du site forestier de Lejo.

Year	Month sampled	Live weight as a percentage of total biomass									Total biomass (gm)
		egg masses	larvae (*)	pupae (*)	queen larvae	queen pupae	alate queens	dealate queens	males	Workers	
1971	August	0.01	5.74	19.34	0	0	0	0.51	0	74.39	35.15
	September	0.04	3.22	19.00	1.01	0.38	0	1.38	0	74.93	31.10
	October	0.03	8.35	33.37	0	0.11	0.16	0.11	0.42	57.41	40.35
	November	0.03	7.62	18.80	0.55	14.17	2.66	1.15	0.33	54.64	47.20
	December	0.05	17.72	29.61	0	0.05	2.05	1.28	0.27	48.95	51.32
1972	January	0.03	9.98	20.78	0	0.42	4.60	1.44	0.01	62.71	28.28
	February	0.01	1.87	13.33	0	0	0	0.87	0	83.91	60.02
	March	0.01	2.79	16.85	0	0	0	1.26	0	79.06	51.97
	April	0.07	6.41	8.93	0	0	0	1.56	0	83.00	21.75
	May	0.03	4.86	8.10	0	0	0	1.04	0	85.67	38.78
	June	0.03	3.91	0.93	0	0	0	1.04	0	94.07	15.18
	August	0.01	0.76	2.07	0	0	0	0.49	0	96.67	23.17
	October	0.01	3.50	4.12	0	0	0	2.16	0	90.20	15.75
	December	0.03	10.46	29.70	0.75	2.32	0.97	0.57	0.29	54.86	27.71

(*) Excluding sexual brood.

DISCUSSION

In a study of *A. longipes* in Indonesia VAN DER GOOT (1916) found that males and alate queens only appeared during the second half of the east monsoon after a prolonged period of low rainfall. In the Solomon Islands, GREENSLADE (1971 *b*) found a wet season maximum in numbers of queen brood, although winged sexuals were present throughout the year. A similar seasonal life cycle is shown by this study. The initiation of sexual brood production is obviously dependent in *A. longipes* on the onset of the wet season. How this dependence operates has not been elucidated by this present study. In the British Solomon Islands, GREENSLADE (1971 *a*) found that rainfall increased the protein portion of the food supply of *A. longipes* as prey was more abundant under wet conditions. There was also a reduction in foraging activity by *A. longipes* in coconut palms harbouring honeydew-producers which he interpreted as a change in activity from the gathering of honeydew to a searching for prey in the ground layer. Greenslade concluded that this increase in the availability of prey coupled with the increased taking of prey by *A. longipes* was adequate to explain the seasonality of *A. longipes* in the British Solomon Islands.

In the Northern District of Papua New Guinea it has not been demonstrated that there is a change in the food source during the early part of the wet season. However, the large increase in the biomass of colonies during the sexual brood production period indicates that food intake by colonies must have been increased to produce and sustain the larger biomass. As there was no increase in the worker population over this period, there had either been a substantial increase in the efficiency and/or intensity of foraging activity or else a change in the food source. No data was collected during this study which lends support to either contention.

The time of appearance of males in colonies appeared from the results to bear little relationship to the abundance of alate queens. At the rain forest site, males appeared in large numbers before the appearance of the majority of alate queens and declined to insignificant numbers whilst queen brood production was still in progress. In fact, at the January 1972 sampling there was a large number of alate queens and it is doubtful if a high proportion of these would have had the opportunity to mate after their dispersal in February. At the cacao plantation site no males were recorded after December 1970 even though alate queens together with queen larvae and queen pupae continued to be present. Alate queens remained in low numbers at this site until June 1971.

Worker brood production increased at the end of the wet season due to the increased number of dealate queens present in colonies. However, production of worker brood was not maintained at the same level throughout the dry season.

At the rain forest site, the production of worker brood during the mid-year

dry season showed great differences between the years 1971 and 1972 (Table II). The dry season of 1972 was particularly harsh and prolonged, and this appeared to have had an adverse effect on the production of worker brood.

At the cacao plantation site, the decline in the production of worker brood from February 1971 onwards was associated with an instability of the population, induced by the adoption and retention of an abnormal number of dealate queens. This decline was irreversible. No colonies were found in the trial area when the cacao block was re-examined in July 1973.

At the rain forest site, the population (density of colonies and intensity of foraging activity) was stable throughout the trial period and was unchanged when the trial area was re-examined in July 1973.

Acknowledgements. — The author would like to thank Mr. D. TAGO, Research Assistant, Department of Agriculture, Stock and Fisheries, Popondetta, for assistance with the collection of samples from the Lejo site; Mr. O. PEREKANG and Mr. Y. ESAV of Mt. Hagen, for assistance with the scoring of life-history stages; and Dr. P. J. M. GREENSLADE, Commonwealth Scientific and Industrial Research Organisation, Glen Osmond, South Australia, for critical reading of the manuscript.

REFERENCES

BAKER (G. L.), 1972. — The role of *Anoplolepis longipes* (Jerdon) (Hymenoptera : Formicidae) in the entomology of cacao in the Northern District of Papua New Guinea. *Abstr. 14Int. Congr. Ent., Canberra,* abstr. 327.

BRUNEAU DE MIRÉ (Ph.), 1969. — Une Fourmi utilisée au Cameroun dans la lutte contre les mirides du cacaoyer : *Wasmannia auropuncta* Roger. *Café Cacao Thé, 13,* 209-212.

ENTWISTLE (P. F.), 1972. — Pests of cacao. *Longmans,* édit., London, 779 p.

GREENSLADE (P. J. M.), 1971 *a*. — Interspecific competition and frequency changes among ants in Solomon Islands coconut plantations. *J. appl. Ecol., 8,* 323-349. — 1971 *b*. Phenology of three and species in the British Solomon Islands. *J. Aust. ent. Soc., 10,* 241-252.

KOPPEN (W.), 1936. — Das geographische System der Klimate. *In :* Handbuch der Klimatologie, vol. I. *Gebruder Borntrager,* édit., Berlin, 44 p.

LESTON (D.), 1973. — The ant mosaic-Tropical tree crops and the limiting of pests and diseases. *PANS, 19,* 311-341.

SLATYER (R. O.), 1964. — Climate of the Buna-Kokoda area. *In :* Lands of the Buna-Kokoda area, Territory of Papua New Guinea, Land Research Series No. 10, Australia. *Commonwealth Scientific and Industrial Research Organisation,* édit., Melbourne, 113 p.

VAN DER GOOT (P.), 1916. — Verdere onderzockirgen omtrent de oeconomische beteekenis der gramangmier. *Meded, v. h. Proefstation Midden-Java, Salatiga,* n° 22, 1-122.