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Dry Season Egg Pod Survey and Eclosion in *Oedeleus senegalensis*, Krauss (Orthoptera: Acrididae) in the Sudan Savanna of Nigeria

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ABSTRACT

Status of eggs and egg pods of *Oedeleus senegalensis* in Maiduguri metropolitan Area at Ngom south, Ngom north, Molai and Bulunkutu, on previously cultivated millet fields were studied. The result revealed that egg pods densities were generally low, hence upsurges are not expected. But egg pods distribution was usually un-even, being contagious, but random in Bulunkutu with fewer egg pods. These egg pods are non-uniform in structure the base were smaller and egg pods from Bulunkutu are longer. Predation by *Systoechus* larvae was most severe at Ngom south and north. Also an inversely proportional relationship exists between egg pod density and number of eggs per pod. Transverse sections show stages of eclosion up to formation of embryonic germ band under laboratory conditions, however delineation and gastrulation stages were not observed.

Key Words: Egg pod; Dry season; Nigeria

INTRODUCTION

Oedeleus senegalensis (Krauss) is a Sahelian or Senegalese grasshopper. These are medium size black grasshoppers, which exhibit migration in loose swarms. Jago (1979) provided key for species identification. *Oedeleus* usually concentrate around the Sahelian zones of Mauritania (Lat.17^{0}N) in the north, to Burkina Fasso in the south, terminating slightly below Maiduguri (Lat.11^{0}N). Movements within the zone is in north-south direction within 1000 mm isohyet (Lat.11^0-12^{0}N) southern limit and 150 – 200 mm isohyet (Lat.17^0-18^{0}N) northern limits. Within these limits the population moves seasonally in the wave of the inter-tropical convergence zone (ITCZ) or Inter-tropical Front (ITF). The movement is northwards in June-July and southwards in September-October (Popov, 1988).

These grasshoppers preferentially attack cultivated pearl millet *Pennesitum* spp, in the seedling, foliage, milky and cheese stages, *Sorghum bicolor* and other cereals are attacked to a lesser extent. Being multivoltine, it exhibits facultative diapause. Males mature first, produces pheromones, which stimulate ovarian development in females. Gravid females of the last generation in a year lay 20 - 46 (Av.28) eggs per pod, between September-October into egg pods plugged with frothy saline secretions, the females pheromones further accelerates maturation of immature females (Anene, 1992). Eclosion occurs with early rains (25 – 30 mm) between May-June, incubation period lasts 12 - 15 D under ambient Sahelian conditions (Popov, 1980 & 88; Buahin, 1994). The resulting fledgelings attack seedlings of cereals. Three or rarely four generations are produced per year in the Sahel. Swarms of the last generation normally invade northern Nigeria from Niger and Chad republics in drought years (FAO/UN, 1987). Level of injury caused to millet seedlings depends upon populations of *Oedeleus* hoppers in the crop fields.

Survey of *O. senegalensis* egg pods should be confined to typical egg laying habitats, like millet fields and their periphery, open or lightly wooded sandy steppes with grasses like, *Cenchrus biflorus, Aristida stipagrostis* and *Eragrostis* species (Popov, 1980; Anaso & Buahin, 1993). Furthermore, actual observation of their presence, damage to plants and abundance of frass (faeces) are indicators to earlier reproductive or mere visitation by adults (Cheke *et al.***,** 1980a). Egg pods are laid indiscriminately in the upper 6 cm of soil and projects about 0.2 - 0.3 cm when cleared with a shovel (Popov, 1980; Anaso & Buahin, 1993). Cheke *et al.* (1980a) reported *O. senegalensis* usually oviposit on or near slopes. These egg pods are index of level of subsequent damage to seedlings, while determinant factors are population densities of viable eggs and subsequent fledgling success.

Economically, these grasshoppers constitute a hindrance to millet production within the Sahelian region (Cheke *et al.*, 1980a; Popov, 1980 & 88). The last major upsurge occurred in 1985 - 1987 (FAO, 1987), when losses exceeded 70% in many local government areas of Bauchi, Borno, Kano and Yobe states. Dan-manoma village of Gumel emirate lost a whole years harvest to *Oedeleus* in October, 1977 and 1986. In combination with other grasshopper speices, defoliation and field crop losses in the Savanna is greatly threatened hence, hunger and starvation is eminent. These estimates reveal the seriousness of grasshopper problems in northern Nigeria to warrant studying for effective control (Amatobi, 1986). Preventive control is most economical and functional in protecting cultivated millets from ravages of *Oedeleus* by exploiting early identification of high density egg laying (Red zones) sites of this grasshopper. This study evaluates the activities of *O. senegalensis* in Savanna fields during dry season and eclosion as critical factors in next cropping season invasion of millet fields.

MATERIALS AND METHODS

Egg pod sampling, were conducted in four sites with indicators for grasshopper activities in the previous cropping season. Five 4 m^2 plots were demarcated randomly from every 5 ha, in a north-south direction. Using a shovel, the upper 1 - 3 cm of top soil is removed, with an empty motorized knapsack mist blower, thin layer of loose dust on marked plots were blown out. Exposed egg pods were measured using the nearest Neighbour Technique of Stephen and Gary (1980). Egg pods were carefully removed using a sharp knife. Excavated egg pods total length and width, were measured, while number of eggs per pod and predation status of egg pods recorded. Finally five egg pods were incubated artificially by soaking in moist cotton wool and maintained in water bath at 35 - 40^0C. Using the paraffin wax method of Drury *et al.* (1967), the internal structures of developing eggs were recorded from prepared microscopic slides.

RESULTS

The mean egg pod density is highest at Ngom north (2.14) and least at Molai (0.47), but not significantly different. Peak laying density was at Ngom north, plot 4 (Table I). Distribution coefficient (R) is highest at Ngom south and north, being generally contagious, except for Bulunkutu where it is random. Mean R, are not significantly different amongst the four sites. Only plot 5 in Molai had egg pods, while plot 2 had only one, making calculation of R, impossible (Table II).

Mean dimension of the dry season egg pods gave higher length at Bulunkutu. The top as against the base being wider (Table III). Percentage predation was high in Ngom south and north, between 23.1 - 100%, but least at Molai and Bulunkutu. However differed significantly between the four sites (Table IV).

The number of eggs oviposited per pod was highest at Bulunkutu with a mean 34.4 eggs/pod, least being 28.8 eggs/pods from Ngom north. Nevertheless, number of eggs deposited per pod is not significantly different between pods obtained from the four sites (Table V). Least eclosion was in the 5^{th} egg pods, while the 4^{th} recorded peak mean emergence. Eclosion normally terminates by week 3, except for the first egg pod. Maximum emergence occurred in week 2 in all incubated egg pods. However, eclosion between the egg pods are not significantly different (Table VI).

Transverse sections show stages of eclosion in *O. senegalensis* eggs, soaked and incubated for four weeks. Yolk complements being syncytial, occasionally enclosed by a membrane from the periplasm. Cleavage energids initially scanty, multiplies, begins compaction and localization (Fig. 1). These form into Primordeum cells (blastoderm cells), giving rise to embryonic Primodeum (Fig. 2). Finally differentiates into Protocephalon and Protocorm. The resulting polarized germ band (Fig. 3) commences delineation and gastrulation stages not observed in this study.

Table I. Dry Season egg pod densities (m^2) of *O. senegalensis* in previously cultivated millet fields

Plot number	Locations			
	Ngom South	Ngom north	Molai	Bulunkutu
1	1.22	1.41	-	1.50
2	1.66	2.06	1.12	1.32
3	1.41	2.24	-	1.41
4	1.89	2.83	-	1.12
5	2.00	2.18	1.22	1.32
Mean	1.63	2.14	0.47	1.33

SED = 0.22; LSD (0.05) = 2.4, CV = 1.47

Note: Values are square root (√x¯) transformed

Table II. Distribution Coefficient (R) of *O. senegalensis* egg pods using 'Nearest Neigbhour Technique

Plot number	Locations			
	Ngom South	Ngom north	Molai	Bulunkutu
1	1.24	1.28	-	1.22
2	1.57	1.77	-	2.00
3	1.89	1.98	-	1.64
4	2.01	2.11	-	-
5	1.41	1.84	2.23	2.18
Mean	1.62	1.80	0.45	1.41

SED= 0.88. $LSD_{(0.05)}$ = 1.92, CV = 6.07

Note: If R = 1, distribution is random; R=0, maximum aggregation, and R=2.149, contagious.

Table III. Mean dimension (cm) of *O. senegalensis* dry season egg pods

Locations	Length	Diameter	
		Base	Top
Ngom south	5.39±0.69	0.44±0.03	0.46±0.5
Ngom north	5.70±0.42	0.42±0.02	0.45±0.01
Molai	5.20±0.59	0.49±0.04	0.51±0.03
Bulunkutu	7.42±0.03	0.49±0.04	0.51±0.05
CV (%)	17.2	7.4	6.7

Note: Values are means from five plots per site (location).

Table IV. Percentage predation of dry season egg pods of *O. senegalensis* in previously cultivated millet fields

Plot number	Locations			
	Ngom South	Ngom north	Molai	Bulunkutu
1	100(10.0)	75(8.7)	0.0	20(4.5)
2	100(10.0)	23.1(4.8)	100(10.0)	0.00
3	75(8.7)	75(8.7)	0.0	0.0
4	80(8.9)	64.3(8.0)	0.0	0.0
5	83.3(9.1)	66.7(8.2)	0.0	50(7.1)
Mean	9.34	7.68	2.0	2.32

SED = 0.20, LSD (0.05) = 2.61, CV = 4.11.*Note:* Figures in parenthesis are⁄percent.

DISCUSSION

Although high egg pod densities was not observed in any of the study locations. Anaso and Buahin (1993) stressed that egg pod density of 2.5 m^2 was needed for upsurges of this grasshopper, with a peak of 2.14 egg pods

Table V. Number of eggs of *O. senegalensis* per pod

Egg pods Number	Locations			
	Ngom South	Ngom north	Molai	Bulunkutu
1	28	38	24	30
2	36	22	40	34
3	26	24	-	38
4	36	32	-	32
5	26	28	-	38
Mean	30.4	28.8	-	34.4

SED = 3.41; LSD (0.05) = 7.43, CV = 5.28

Table VI. Adult emergence after four weeks incubation of *O. senegalensis* egg pods in the laboratory

Duration in weeks	Incubated egg pods				
	1st	2nd	3rd	4th	5th
1	-	7.69(2.95)	-	12.5(3.54)	-
2	16.67(4.08)	30.77(5.55)	33.33(5.77)	9.38(3.22)	35.71(5.98)
3	8.33(3.05)	3.85(2.20)	33.33(5.77)	6.25(2.69)	10.71(3.27)
4	4.17(2.27)	-	-	-	-
Mean	2.35	2.68	2.89	2.36	2.31

SED = 0.58, LSD (O.05) = 1.25, CV = 23
Note: Values in parenthesis are percent.

m^{-2}, outbreak is not expected. Distribution of egg pods were usually un-even, showing clumpines, hence the contagious distribution recorded. This relates possibly to millet stands in the field, pheromonal attraction for oviposition and gravid females being earth bound with oocytes in the ovarioles, soil moisture, salinity, other climatic factors and adaptation to common laying fields (Jago, 1979; Cheke *et al.*, 1980b; Popov, 1988; Buahin, 1994).

Against 'concept of egg pods uniformity' in *O. senegalensis* (Popov, 1988) eggs pods from Bulunkutu differed significantly in length. Although both locations are annually ploughed, yet soil characteristics differ in texture, colour and amount of silt, both being more compact than in Bulunkutu. Mean diameter at the top were slightly larger than the base, possibly due to vibrational movements during egg pods construction, subsequent oviposition by gravid females and size of the first abdominal segment.

Egg pods predation was most severe at Ngom south and north, caused by larvae of *Systoechus* species. Cheke *et al.* (1980b) reported that high predation and parasitism is associated with high rate of laying. An area could be heavy monsoon breeding site, yet with little or no end of season laying e.g., Molai. Buahin (1988), reported 12 - 40 eggs/pod, also that number of egg pods in a field is inversely proportional to number of eggs/pods. This agrees with the findings in this work.

Factors other than moisture and temperature were necessary to initiate egg development; either synchronous or staggered hatching depend on amount of initial development prior to developmental arrest, maturation time and other physiological process. Cheke *et al.* (1980b) observed that egg development in *O. senegalensis* is complex, undergoing series of temporary interruptions or obligatory diapause. However, with return of favourable condition, resumes development, hence the observed staggered hatching recorded in this experiment. Egg predation, mechanical damage or non-fertilization may account for failure to hatch completely (Popov, 1980; Cheke *et al.*, 1980b).

Fig. 1. Embryonic yolk stages

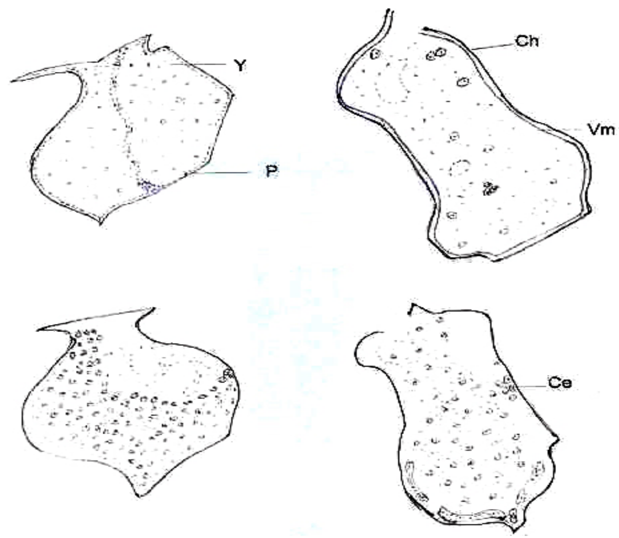
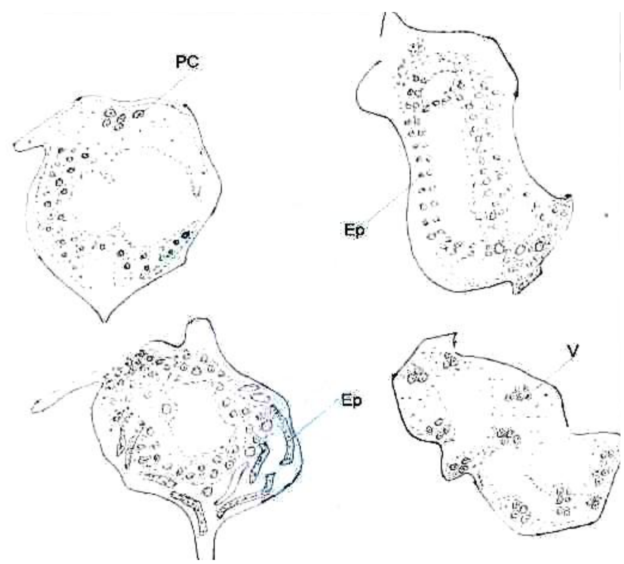
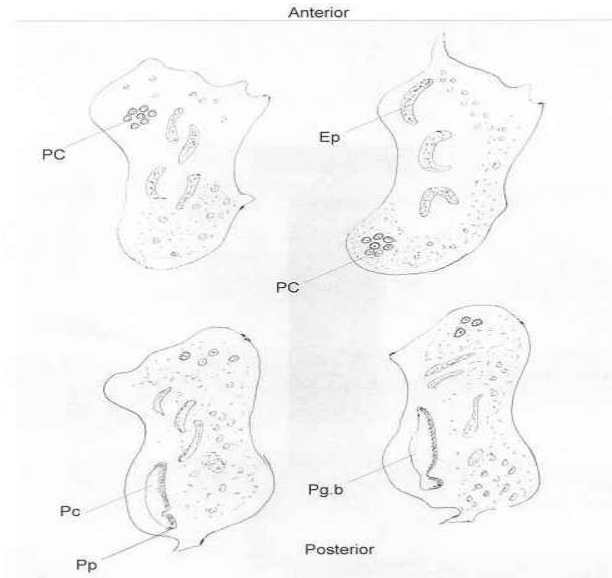


Fig. 2. Blastodermal cell stages



Transverse sections show stages of eclosion in *Oedeleus* eggs incubated for four weeks, with large yolk oocyte enclosed by an inner vitalline membrane and an outer chorion. Zygote enters into series of repeated nuclear division, each daughter nuclei become enclose in an Island of cytoplasm as 'cleavage energids'. Complete coverage of the cytoplasm by these energids and disappearance of the vitalline membrane are proof of embryogenesis (Fig. 1). Cleavage energids migration to the periplasm, concentration at localized centres and compaction give rise to the Primordial cells (blastoderm cells). Along with production of vitallophage for yolk digestion, enters an advanced stage in insect development (differential blastoderm), producing the embryonic Primordium (Fig. 2). These migrate to the

Fig. 3. Embryonic germ stages



posterior poles to form the polarized embryonic germ cells. This deduction confirms the concept that "anterior cleavage centres initiates nuclear division and migration, while the posterior pole has activation centres". Communication between these two centres is by chemical substances (Popov, 1980; Cheke *et al.*, 1980b). The embryonic germ cell divides into anterior head lobe (protocephalon) with antennal and pre-antennal rudiments, while protocorm forms the post antennal (growth zones) segments, with elongation primordium germ band results (Fig. 3), delineation and gastrulation stages however not observed.

It is possible to predict *Oedeleus* upsurges several months before commencement of the cropping season. In view of the fact that north-east zone is prone to this upsurges, egg pod survey carried out extensively to establish red zones and control measures applied early is recommended. This has practical, ecological and economic significance in cereals production.

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