HENOSEPILACHNA VIGINTIOCTOPUNCTATA (FAB.) (EPILACHNINAE; COCCINELLIDAE); ITS TAXONOMY, DISTRIBUTION AND HOST PLANTS IN PAKISTAN.

FALAK NAZ*, MIAN INAYATULLAH***, M. ATHER RAFI*,
MUHAMMAD ASHFAQUE** and ASAD ALI****

* *National Insect Museum, IPEP, NARC, Islamabad – Pakistan.*
** *Insect Pest management Programme, IPEP, NARC, Islamabad – Pakistan.*
*** *Department of Entomology, Agricultural University, Peshawar – Pakistan.*
**** *Department of Entomology, Abdul Wali Khan University, Mardan – Pakistan.*

ABSTRACT

The hudda beetle or epilachnine beetle, Henosepilachna vigintioctopunctata (FAB.) is a serious and widespread pest of Solanacious vegetables. Specimens were collected from Islamabad, Khyber Pakhtunkhwa: Peshawar, Charsadda, Mardan, Buner, Swat, Mansehra, Balakote, Abbotabad, Haripur, D. I. Khan, Tank, AJK: Rawlakote, Kotli, Hajeera, Abbaspur, Punjab: Attock, Jehlum, Kalar Kahar, Sialkot, Lahore, Jhang, Multan, Bahwalpur, Faisalabad, Lahore, Sindh: Sukkar, Nawab Shah, Larkana, Karachi and Quetta. The species were identified on the basis of genitalia in National Insect Museum, NARC, Islamabad, Pakistan. It was found while feeding on brinjal Solanum melongena, S. nigrum, S. surretanses, Datura, tomato Lycopersicum esculantum and Physalis sp. Further its extreme variability of pronotal and elytral spots is also analyzed here.

Key Words: Henosepilachna vigintioctopunctata (FAB.) **Pakistan, taxonomy, distribution, host plants and spot pattern.**

Citation: Naz, F., M. Inayatullah, M.A. Rafi, M. ashfaque and A. Ali. 2012. *Henosepilachna vigintioctopunctata* FAB; Its taxonomy, distribution and host plants in Pakistan. Sarhad J. Agric. 28(3):421-427

INTRODUCTION

Henosepilachna vigintioctopunctata is a serious pest of Solinaceous crops such as egg plant and potato over a wide range from Japan (Nakamura, 1976) to South Asia and Australia (Kalashoven, 1981; Richards, 1983). In Pakistan, *H. vigintioctopunctata* can be found with varying degree of population densities in all the areas where the host plants are grown (Hashmi, 1994).

This epilachnine beetle is polyphaguous and is a serious pest of various vegetable crops belong to family Solanaceae.. Schaefer (1983) listed many cucurbitaceous plants together with Solanaceae as host plants of *H. vigintioctopuntata*. Moreover, it is as recorded pest of cucurbitaceous crops in India (Pareek and Karadia, 1991). Similarly its larvae and adults have been found feeding on nightshades, trumpet flower weed (*Datura stramonuim*), cucumber, melon and cotton (Froggatt, 1923).

The generic classification of *Henosepilachna vigintioctopunctata* has been a matter of controversy. Initially this species was included in genus *Epilachna* but Li and Cook (1961) erected the new genus *Henosepilachna* and this species was categorized under it. Again Kapur (1967) retained the use of *Epilachna*, and Richards (1983) considered *Henosepilachna* to be a synonym of *Epilachna.* However other authors, for example Hoang (1977), Fürsch (1991) and Li (1993), have maintained *Henosepilachna* as a distinct genus.

The species name has also been used for at least two different biological species. The species referred to as *E. vigintioctopunctata* in the monographs by Dieke (1947) and Bielawski (1963) is a cucurbit feeder now known as *Henosepilachna cucurbitae* Richard. Kapur (1967), following the tradition of the major 19th-century authors, used the name *E. vigintioctopunctata* for the present species, and this action was shown to be corrected by Richards (1983). Several other names have also been used for this species and many of them were listed by Richards (1983). The most important of these synonyms are *Epilachna sparsa* or *Henosepilachna sparsa* (Herbst).

The taxonomy of this species remains confusing throughout history because of its wide variation in external appearance. This resulted in number of misidentification in the past. In Pakistan this species has been

called *Epilachna sparsa* (Ashrafi, 1956; CIBC, 1982) and *E. 28-punctata* (Hashmi, 1994). This article will clarify the exact identification of this pest species.

Another problem related to this epilachnine species is that it exhibits extreme intraspecific variations in body size, shape, pronotal and elytral spots, colour tone of elytra and melanization of ventral parts. Such variation can be found among the specimens of different localities as well as among specimens found in the same locality. Rich intraspecific variations in elytral spots pattern has been studied in tropical and sub-tropical epilachnines (Dieke, 1947; Kalshoven, 1981, Abbas, *et al*., 1988). According to Abbas *et al*. (1988) the variation is correlated with altitude i-e the number of non-persistent spots increases with increase in altitude. In this article we analyze this variation on the basis of specimens collected from different altitudes in Pakistan.

The present article will provide notes on different aspects of *H. vigintioctopunctata* from Pakistan.

MATERIALS AND METHODS

Sample Collection

A large number of *Henosepilachna vigintioctopunctata* specimens were collected during 2007-2009 from various localities in four provinces Khyber Pakhtunkhwa: Peshawar, Charsadda, Mardan, Buner, Swat, Chitral, Mansehra, Balakote, Abbotabad, Haripur, D. I. Khan, Tank; Punjab: Islamabad, Attock, Jehlum, Kalar Kahar, Sialkot, Lahore, Jhang, Multan, Bahwalpur, Faisalabad, Lahore; Sindh: Sukkar, Nawab Shah, Larkana, Karachi and Baluchistan; Quetta and Loraralai, including Azad Jammu & Kashmir: Rawlakote, Kotli, Hajeera, Abbaspur. Host plants were searched during the survey. Some specimens were reared from their larvae and pupae to their adult stage. All the specimens were pinned and labeled properly.

Host Plant Study

The host plant on which the adult and larvae were found while feeding were also collected or noted. The plants difficult to identify were identified from Botanists.

Spots Study

The elytral and pronotal spots variations was studied followed the model (Fig. 2) given by Dieke (1947).

Genitalia Extraction

The method of Majerus & Kearns (1989) was followed for genitalia extraction and mouth parts study with some modification. First of all, abdomen of the beetle was detached after soaking in water and gentle heating. The detached abdomen was boiled in 10% KOH solution for 30 minutes. Then transferred to pure glacial acetic acid for 5 minutes, washed in water, dehydrated by passing through a series of alcohol of increasing concentration and then removed to clove oil. The processed abdomen was put under stereoscope, opened with the help of two needles (one pointed and one hooked) and the genitalia was extracted. The male genitalia was mounted on a cardboard with the help of hydrosolouble glue and the female genitalia on a stripe of transparent plastic with Euparal.

RESULTS AND DISCUSSION

Henosepilachna vigintioctopunctata (FABRICIUS)

1775 *Coccinella vigintioctopunctata* Fabricius,: 84.
1786 *Coccinella sparsa* Herbst: 160
1835 *Coccinella pardalis* Boisduval: 596
1850 *Epilachna undecimvariolata* Mulsant (not Boisduval): 780-782; Crotch, 1874: 85
1850 *Epilachna territa* Mulsant: 787 (synonymised by Richard, 1983: 18)
1850 *Epilachna gradaria* Mulsant,: 789-791.
1850 *Epilachna vigintioctopunctata* (Fabricius) Mulsant,: 834; Korschefky, 1931: 26; Kapur, 1967: 152; Richard, 1983: 15.
1931 *Epilachna vigintioctopunctata* ab *pardalis* (Boisduval) Korschefsky: 26.

1983 *Epilachna vigintioctopunctata vigintioctopunctata* (Fabricius), Richards: 17
1983 *Epilachna vigintioctopunctata pardalis* (Boidsduval): Richards: 21.
1947 *Epilachna sparsa* (Herbst): Mulsant, 1850: 837; Dieke: 22-29; Bielawiski, 1957: 73; Fursch, 1959: 2.
1947 *Epilachna sparsa sparsa* (Herbst): Dieke: 32; Bielawiski, 1961: 228
1947 *Epilachna sparsa* var. *gradaria* Mulsant: Dieke: 32.
1947 *Epilachna sparsa orientalis* Dieke: 34 (synonymised by Richard, 1983: 18).
1947 *Epilachna sparsa orientalis* var. *cinerea* Dieke: 35.
1947 *Epilachna sparsa territa* Mulsant: Dieke: 35.
1947 *Epilachna sparsa vagintisexpunctata* Dieke: 36; Bielawiski, 1959:147
1947 *Epilachna sparsa vagintisexpunctata* var. *nigrescens* Dieke: 37.
1850 *Epilachna pardalis* (Boisduval): Mulsant: 840.
1850 *Epilachna territa* var. *indocilis* Mulsant: 788. (Synonymised by Richard, 1983: 18).
1850 *Epilachna gradaria* var. *addita* Mulsant: 791 (synonymised by Richard, 1983: 18).
1850 *Epilachna gradaria* var. *vieta* Mulsant: 791.
1850 *Epilachna gradaria* var. *socors* Mulsant: 791 (synonymised by Richard, 1983: 18).
1850 *Epilachna gradaria* var. *congressa* Mulsant: 791.
1850 *Epilachna gradaria* var. *stolida* Mulsant: 791 (synonymised by Richard, 1983: 18).
1961 *Henosepilachna sparsa* (Herbs): Li and Cook: 40; Bielawiski, 1965a:535; 1965b: 211.
1971 *Henosepilachna vigintioctopunctata* (Fabricuius): Sasaji: 309; Hoang 1977: 133; Li, 1993: 211; Katakura *et al*, 2001: 327; Jadwiszczak & Wegrzynowicz , 2003: 178-180.

Taxonomy

Diagnosis

Ground colour pale brown or reddish brown. Elytral apex angled. First coxal line subcomplete. Elytral spots vary between 12 and 28 but mostly with 26 spots. Spot cb3d usually lie on a straight line. Exact diagnosis can be made by examining male genitalia with a well developed basal knife edge and apical thorn on median lobe, siphonal tip tapering on one side. Female genitalia with a deep notch on inner edge.
Size: Male (N=73), 6.0 ± 0.13 mm; Female (N=56), 6.5 ± 0.08 mm.
Genitalia: Male genitalia (Fig. 3); Median lobe has basal knife edge beginning at the foot of paramera and a buldge beyond the middle, after which it curves up into an apical hook. Second half with two rows of hairs. Paramera with an apical thorn and covered with hairs shorter than those of median lobe. Siphon gently curved near the base, then straight, ending in a point. Female genitalia (Fig. 4); female genital plates has an excavation on the underside with a sharp dark edge toward apex.

Maculation

Pronotal Maculation

The pronotum presents variable maculation. From the spotless form to the form with all 7 spots. About 120 specimens collected from different localities were studied for their pronotal spot maculation. Following types of maculation pattern were recorded:

Table I ***Pronotal Spot pattern variation in Henosepilachna vigintioctopunctata***

S. No.	Pronotal spot pattern	Number of specimens	Percentage
1	Pronotum with all 7 spots	24	20.00
2	Pronotum with spot 7 missing	65	54.17
3	Pronotum with spots 5,6,7 missing	6	5.00
4	Pronotum with spots 3,4, 7 missing	6	5.00
5	Pronotum with spots 1, 2 present	10	8.33
6	Pronotum with spots 1,2,7 present	2	1.67
7	Pronotum spotless	7	5.83
	Total	120	100

The data reveal that in majority of the specimens 7 pronotal spots are present in which the spot 7 is present hazily (20 %) or missing entirely (54 %). Spotless pronotum is also exhibited by some specimens beside some intermediate maculation. Dieke (1947) and Katakura *et al*., (2000) also reported such type of pronotal maculation from spotless to 7 spots with all intermediates. Pronotal variation is not correlated with altitude and other factors.

Elytral Maculation

The basic pattern of elytral spots as presented by Dieke (1947) consists of six black "persistent spots" numbered as 1 to 6 and eight "non-persistent spots" numbered as *a-h* on each elytron as given in Figure 2. Dieke (1947) further stated that only the non-persistent elytral spots vary in number and hence various modifications appear in elytral maculation. These spots also form some confluence (mixing of spots). We also observe great variation in *H. vigintioctopunctata* in our collection and try to classify such variation on the basis of position of the non-persistent spot and their total number on each elytron in Table. II. For example, a specimen having non-persistent spots "*adgh*" is counted separately in columns *a, d, g* and h and is also in the "4 non-persistent spots" class.

Table II shows the appearance of non-persistent spots on the specimens from various localities ranging from low altitude (30 m) to high altitude (1600 m). In Islamabad, the non-persistent spot "*a*" is missing in majority of specimens and appear only in 7 % specimens followed by spot *f* and *g*. Majority of the specimens have all 8 or 7 non-persistent spots while only 3.45 % are without non-persistent spots. In Peshawar, spot *f* and *g* appear in less number while other spots appear almost in equal number. Here also majority of the specimens have all 8 non-persistent spots followed by 7 spots. No specimens are without non-persistent spot. In the specimens from Mansehra/Abbotabad spots *a, e, f, g* are sometime missing but majority of the specimens have all 8 non-persistent spots followed by 7 spots. In the specimens from Sukkar/Nawabshah, spots *f* & *a* appear in less number with 5.88 % and 10.34 % respectively. Here also majority of the specimens have maximum number of non-persistent spots. In Bagh/Rawlakot, also spots *a, e, f* and *g* appear in less number. However, majority of the specimens here have 6 non-persistent spots followed by 8 and 5. By taking overall specimens, spot *a* is missing in majority of the specimens, represented by only 9.13 % specimens followed by *f* and *g,* both represented by 11.96 % specimens while rest of the non-persistent spots appear almost in equal number. Such findings are supported by Dieke (1947) that spot *a* is mostly disappearing spot and the spot *d* is the last one to go. By taking total number of non-persistent spots per elytron, most of the specimens (40%) have all 8 spots followed by specimens with 7 non-persistent spots.

According to Dieke (1947) the elytra exhibit variation between the forms with 6 spots on each elytron and on the other extreme with all 14 spots present. So any type of elytral spot pattern between 6 and 14 is expected with greatly varying size of the individual spots. He further stated that non-persistant spots are mostly smaller than persistent ones. Such variation can be found among specimens even found in the same locality and among specimens from various ecological regions. Dieke (1947) further stated that such variable appearance of the species has resulted in the misidentification of some of its forms under different names. *E. gradaria* Mulsant with its varieties *addita, veita, socors, congressa stolida* and *E. territa* are probably the forms of *H. vigintioctopunctata*. Such intraspecific variation was also reported in tropical and subtropical epilachnine beetles (Dieke, 1947; Kalshoven, 1981) as well as by Richards (1983) for Australian *E. vigintioctopunctata* populations, by Abbas and Nakamura (1985) for *E. septima* in Padang, Sumatera Barat, by Dharpandra (2001) for *E. septima* in Batichola, Sri Lanka and by Abbas *et al*. (1988) for *E . vigintioctopunctata* population in Sumatera Barat, Indonesia. According to the analysis of Idrus *et al.* (1988) while studying the population of Sumatra, the elytral spot pattern variation is not caused by sex and host plants, however they found that there is positive relationship between the elevation of the sample site and the average number of non-persistent spots per elytron. It means that the number of non-persistent spots increases with the increase in elevation. However our results (Fig. 1) do not support this idea when plotted total number of non-persistent spots against altitude. Katakura *et al* (2000) also stated that the spot variation in Java population is different from that of Sumatra.

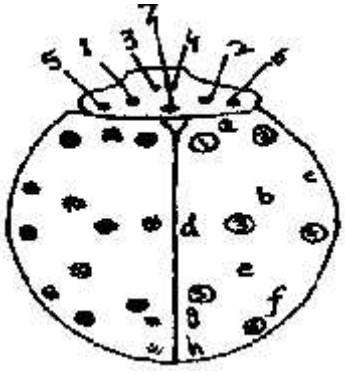

Fig. 2. *Standard Elytral spot numbering as given by Dieke (1947)*

Table II ***Elytral spots pattern variation in H. vigintioctopunctata in Pakistan.***

Group		I		II		III		IV		V		Total	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Individual Position of Non-persistent spots/elytron	a	15	7.0	12	12.63	6	10.34	4	11.76	5	10.89	42	9.13
	b	30	14.0	14	14.74	8	13.04	5	14.70	6	13.04	63	13.10
	c	30	14.0	14	14.74	8	15.22	5	14.70	7	15.22	64	13.91
	d	30	14.0	14	14.74	8	15.22	6	17.65	7	15.22	65	14.13
	e	29	13.55	11	11.58	7	10.98	5	14.70	5	10.89	57	12.39
	f	27	12.62	9	9.47	7	10.89	2	5.88	5	10.89	55	11.96
	g	27	12.62	10	10.53	7	10.89	6	17.65	5	10.89	55	11.96
	h	29	13.55	11	11.58	7	13.04	6	17.65	6	13.06	59	12.82
Total No. of Non-persistent spots per Elytron	0	1 (01)	3.45	0	0	0	0	0	0	0	0	1	1.54
	1	0	0	1 (01)	6.67	0	0	0	0	0	0	1	1.54
	2	0	0	0	0	0	0	0	0	0	0	0	0.00
	3	0	0	0	0	0	0	1(03)	16.67	0	0	1	1.54
	4	2 (08)	6.90	1 (04)	6.67	1(04)	12.5	0	0	0	0	4	6.15
	5	0	0	2 (10)	13.33	0	0	0	0	2(10)	28.57	4	6.15
	6	1 (06)	3.45	2 (12)	13.33	0	0	1(06)	16.67	3(18)	42.86	7	1.52
	7	12 (84)	41.38	5 (35)	33.33	2(14)	25	2(14)	33.33	0	0.0	21	32.31
	8	13(114)	44.83	4 (32)	26.67	5(40)	62.5	2(16)	33.33	2(16)	28.57	26	40.00
	Total	29(213)	100	15(94)	100	8(58)	100	6 (39)	100	7 (44)	100		100
	Avg.	7.34		6.27		7.25		6.50		6.28			

I. represents Islamabad (Avg. Altitude 951 m)
II. represents Peshawar, Mardan, Nowshera (Avg. Altitude 300 m)
III. represents Mansehra/Abbotabad (Avg. Altitude 1150 m)
IV. represents Sukkar/Nawabshah (Avg. Altitude 30 m)
V. represents Bagh/Rawlakote (Avg. Altitude 1600 m)

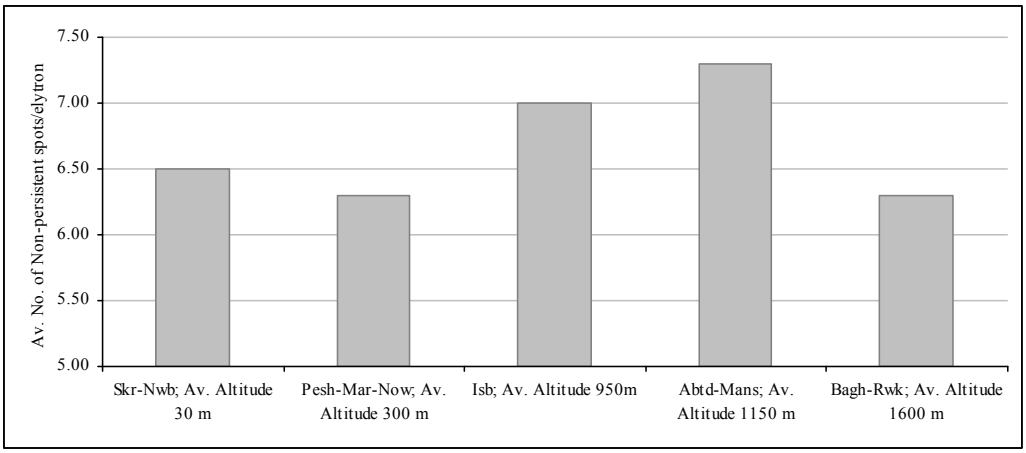

Fig. 1. ***Total number of Non-persistent spots/Elytron at different localities (altitudes)***

Host Plants

During this study, the host plants of *H. vigintioctopunctataon* recorded are *Solanum melongena, S. nigrum, S surretanses, Withania somnifera,* Datur*a, Lycopersicum esculantum* and *Physalis.* CIBC (1982) also recorded it from *S. tuberosum* along with these plants from the country. Anand *et al*., (1988) reported it from *Solanum melongena, S. nigrum, S. surretanses, S. tuberosum, S, carolinense, S. xanthocarpum, S. indicum, S. khasianum, S. pubescent, S. evieulaare, S. insqum, S. torvum, S. megacarpum, Datura fastuosa, D. stramonium, Luffa cylendrica, Withania somnifera, Momordica charantia, Lycopersicum esculantum* and *Physalis maxima*, pumpkin, gourds, zucchini, mamours and cucrbits, *Cucurbita moschata,* cotton, melon, rock melons, cucumber, squash, *Luffa aegytiaca, Lagenaria sp., Vigna ungiculata* (cowpea), *Arachis hypogaea* (groundnut), alfalfa, *Phaseolus mungo*, *Hibiscus esculentum*, *Musa sp.* (banana); *Raphanus sativus* and *Zea mays* from India.

Katakura *et al.,* (2001) reported a long list of it host plants including; *Solanum aethiopicum, S. americanum, capcicoides, S. erianthum, S. jamaicaense, S. macrocarpon, S. mammosum,S. melongena, S. nigrum, S. pseudocapsicum, S. torvum, S. triflorum, S. tuberosum, Brugmansia candida, B. suaveolens, Datura metel, Lycopersicum esculantum, Physalis perviana, Centrosema pubescens* and *Chromolaena odorata* from Java, Indonesia. Shirai and Katakura (1999) reported after many experimentation that although this species has been recorded on cucurbitaceous crops in India (Pareek and Karadia, 1991), Malaysia (Chong *et al*, 1991) and Thailand (S. Chunrun, personal communication), but is unable to complete its life cycle on cucurbitaceous plants. He further stated that some authors have misidentified *H. pusillanima* with this species which is the pest of cucurbitaceous species.

Local Distribution

It is recorded during the survey from Islamabad, Khyber Pakhtunkhwa: Peshawar, Charsadda, Mardan, Buner, Swat, Mansehra, Balakote, Abbotabad, Haripur, D. I. Khan, Tank, AJK: Rawlakote, Kotli, Hajeera, Abbaspur, Punjab: Attock, Jehlum, Kalar Kahar, Sialkot, Lahore, Jhang, Multan, Bahwalpur, Faisalabad, Lahore, Sindh: Sukkar, Nawab Shah, Larkana, Karachi and Quetta. CIBC report (1982) stated that it is widespread in Pakistan and was found from coastal areas to 2000 m in the northern hills.

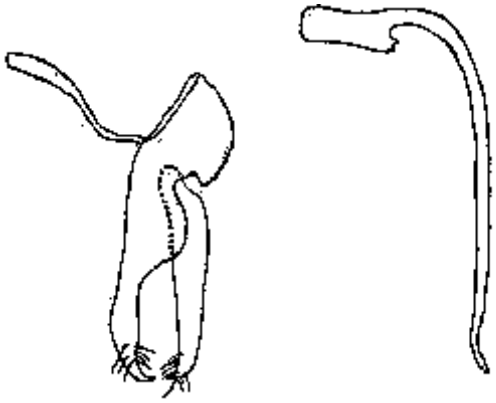

Fig. 3. ***Male genitalia of H. vigintioctopunctata***

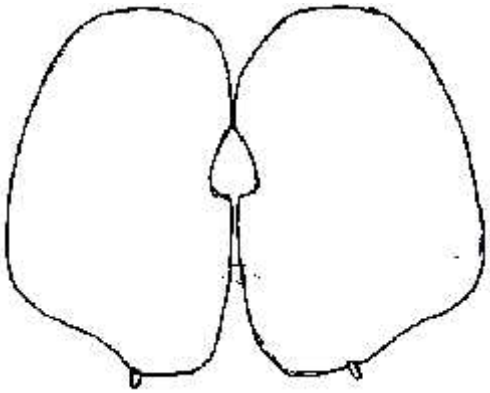

Fig. 4. ***Female genitalia of H. vigintioctopunctata***

CONCLUSION

The study revealed that the pest *Henosepilachna vigintioctopunctata* L. is widely distributed in Pakistan and is polyphagous. However it is more abundant in plain areas. It is a serious pest of brinjal and other solanaceous vegetables. Therefore there is need on further detailed studies on its biology, population dynamics, natural enemies, population diversity, e. g. based on DNA and viable management programme.

REFERENCES

Abbas, I., K. Nakamura, H. Katakura and H. Sasaji. 1988. Geographical variation of elytral spot patterns in the phytophagous ladybird, *Epilachna vigintioctopunctata* (Coleopetra: Coccinellidae) in the province of Sumatera and Barat, Indonesia. Res. Popul. Ecol. 30: 43-56.

Abbas, I. and K. Nakamura. 1985. Variation in elytral patterns in a field population of lady beetle *Epilachna aff. Sparsa* (Coleoptera; Coccinellidae) feeding on bitter cucumber in Sumatra. Sci. Rep. Kanzawa Univ. 30: 27-32.

Anand, R.K., A.K. Gupta and S. Ghai. 1988. A check-list of Indian Epilachninae (Coccinellidae: Coleoptera) with recorded host plants. Bullet. Ent. 29 (1): 121-137.

Ashrafi, S.H. 1966. Biology and morphology of the larva of Bean beetle *Epilachna chrysomelina*. A research monograph. The Times Press, Saddar, Karachi, Pakistan. 63p.

Bielawski, R. 1963. Monographie der Epilachninae (Coccinellide, Coleoptera) der Australian region. Ann. Zool. Warszawa. 21: 295-451.

Chong, K.K., P.A. Cooi and H.C. Tuck. 1991. Crop pests and their management in Malaysia. Tropical press Sdn, Kulalumpur. 242 pp.

Common wealth Institute of Biological Control, Pakistan Station-Rawalpindi. 1982. Investigation on the natural enemies of *Epilachna spp*. in Pakistan. Final Report. 31 p.

Dharmaretnam, M. 2002. A note on the elytral pattern and the bionomics of Epilachna septima in Baticaloa, Sri Lanka (Coleoptera; Coccinellidae). J. National Sci. Foundation, Sri Lanka. 30(1-2): 23-31.

Dieke, G.H. 1947. Lady beetles of the genus *Epilachna* in Asia, Europe and Australia. Smithson. Misc. Coll. 106 (15): 1-183.

Froggatt, W.W. 1923. Insects pests of the cultivated cotton plant. No. 4. Cutworms and leaf-eating beetles. Agric. Gaz. NSW. 34: 48-343.

Fursch, H. 1991. Die Epilachnini Afrikas sudlich der Sahara (Coleoptera; Coccinellidae). Entomofauna, Munchen. 12 (18): 217-316.

Hashmi, A.A. 1994. Insect pest management-Horticulture and Forest crops. Pakistan Agiculture Research Council. Asad Printers, Mughal Market, I-8/1, Islamabad, Pakistan. 2: 346 p.

Hoang, D.N. 1977. Epilachninae (Coleoptera: Coccinellidae) of the North Viet Nam. I. Revue d' Entomologie de I' USSR, Linengard. 56 (1): 132-145.

Kalshoven, L.G.E. 1981. Pests of crops in Indonesia (P. A. VAN LAAN, rev. and transl.). P.T. Ichtair Baru-Van Hove, Jakarta.

Kapur, A.P. 1967. The Coccinellidae (Coleoptera) of the Andamans. Proc. National Instt. Sci. India. 82 B: 148-189.

Katakura, H., S. Nakano, S. Kahono, I. Abbas and K. Nakamura. 2001. Epilachnine ladaybird beetles (Coleoptera, Coccinellidae) of Sumatra and Java. Tropics. 10 (3): 325-352.

Li, C.S. and E.E. Cook. 1961. The Epilachninae of Taiwan (Coeoptera: Coccinellidae). Pacific Insects. 3: 31-91

Li, C.S., 1993. Review of the Australlin Epilachninae (Coleoptera: Coccinellidae). J. Austral. Entomologic. Soc. 32: 209-224.

Majerus, M. and P. Kearns. 1989. Naturalists' Handbook 10 Ladybirds. Richmond publishing Co. Ltd. P.O. Box 963, Slough, SL2 3RS, England.

Nakamura, K. (1976). Studies on the population dynamics of the 28-spotted lady beetle, *Henosepilachna vigintioctopunctata* L. I. Analysis of life table and mortality process in the field population. Jap. J. Ecol. 26: 49-59 (In Japanese with English summary).

Pareek, B.L. and V.S. Karadi. 1991. Incidence on Eilachna beetle, *Epilachna vigintioctopunctata* Fab. On different varieties of musk melon, *Cucumis melo* in the field. Ann. Arid Zone. 30: 163-166.

Richards, A.M. 1983. The *Epilachna vigintioctopunctata* complex (Coleoptera: Coccinellidae). Int'l J. Entomol. 25 (1): 11-41.

Shaefer, P.W. 1983. Natural enemies and host plants of species in the epilachninae (Coleoptera; Coccinellidae), a world list. Agric. Exp. Stn., Univ. Delaware, Bullet. 455: 1-42.

Shirai, Y. and H. Katakura. 1999. Host plants of the phytophagous ladybird beetle *Epilachna vigintioctopuntata* (Coleoptera: Coccinellidae) in Southeast Asia and Japan. Appld. Entomol. Zool. 34 (1): 75-83.