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QUANTITATIVE RELATION BETWEEN ABSOLUTE AND RELATIVE MEASURES OF *CEPHUS FUMIPENNIS* (*HYMENOPTERA: CEPHIDAE*) DENSITIES

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Abstract: *Cephus fumipennis* Eversmann is a key insect pest of wheat crops in Qinghai, China. Its field population densities were surveyed by using both the back-loaded insect vacuum and a sweep net. Mean densities in township-level were calculated and a quantitative relation, $\hat{y} = 0.664 + 0.214x$, was established between the two sampling methods. The empirical relationship may be applicable in density monitoring and Integrated Pest Management program of the insect.

Key words: *Cephus fumipennis*, population density, field survey, sampling method, quantitative relation

INTRODUCTION

The gray-winged wheat stem sawfly, *Cephus fumipennis* Eversmann, is one of the key insect pests of wheat crops in Qinghai Province, China (Zhao et al. 1994, 1995, 1997; QGESA 2000; Zhao 2000, 2005, 2006). Its morphology and taxonomy were presented briefly, and its distribution was indicated in Eurasia (Eversmann 1847; Dovnar-Zapolskij 1931; Gussakovskij 1935; Maa 1949; Stroganova 1976). Antonova (1965) reported the species was a new pest, occurring in USSR, and living in stems of wheat and some other grasses. Zhu and Wang (1959), and Xu and colleagues (XCRTWSS 1980; Xu and Yang 1984) described its infestations in wheat and distributions mostly in the Eastern Agricultural Region (EAR) of Qinghai. Zhao and colleagues estimated its larval optimal sample sizes (Zhao et al. 1994), kernel weight reduction caused by larvae on several wheat varieties (Zhao et al. 1997), and natural resistance of the varieties to the insect (Zhao 2000). Also they studied preliminary regionalization of many wheat-insects, including the pest, in the EAR (Zhao et al. 1995), when they used the back-loaded insect vacuum (BLIV) for the first time to survey the insect's population in the EAR.

Either absolute or relative measures have their own advantages. However, absolute measures are often required in many IPM programs; as a result, much research is needed to be sure that relative measures give an accurate indication of differences in absolute population density (Elkinton 1993).

Although some results derived from using the BLIV sampling method appeared partially (Zhao et al. 1995), comparing the effect of the BLIV with that of a sweep-net in a regression analysis was not published, and nor was similar content seen in this aspect. The purpose of the study was to reveal a quantitative relation between the two sampling methods. It is hoped the relation may be useful in density monitoring and IPM program of the insect.

MATERIALS AND METHODS

A field survey on adult *C. fumipennis* densities was conducted in such seven counties as Minhe, Ledu, Ping'an, Huangzhong, Datong, Huzhu and Huangyuan along the Valley of Huangshui River, from the lower reaches to the upper ones, in Qinghai Province, China. The survey started from 13 June, when local wheat was in flowering stage in Chuankou Township of Minhe County at altitude 1820 m, to 21 June, when local wheat was in boot stage in Chengjiao Township of Huangyuan County at altitude 2630 m.

Sampling tools for the survey were chiefly two kinds: (1) the back-loaded insect vacuum (BLIV, a patent machine granted by the Patent Bureau of China; Zhao et al. 1996); and (2) a standard sweep-net. The tools led to two different sampling methods.

Method I, using the BLIV, sucked the mobile insects on both the surface of the wheat plants and the area aboveground against the inlet of the machine, 10 sucks in each randomly-chosen wheat field constituting a sample, representing the amount of insects per square meter in the field (the diameter of the machine inlet was 0.33 m; supplemented by the vacuuming action along the edge of the inlet, it could actually suck an area close to 0.1 m^2, thus, the total area for 10 sucks equaled to approximate 1 m^2).

Method II, using a standard sweep-net, caught the mobile insects flying or moving on the canopy of wheat plants in the same field, 50 nets for a sample, representing the amount of mobile insects per 33 square meters on the canopy of wheat plants (the diameter of the sweep-net was 0.33 m, and the length for sweeping one net was close to 2 m, thus, $0.33 \times 2 \times 50 = 33$). Sampling Method II functioned in fact as a contrast of Sampling Method I in the survey.

Fields that were sampled were randomly chosen: 3 to 6 wheat fields in a village, 1 to 3 villages in a township, and 1 to 5 townships in a county.

All the samples taken were fumed to cause the insects to die or to be paralyzed immediately, and they were brought to the laboratory in northern Xining, examined and recorded according to species, genus, or family with their numbers. The mean density of each species (or genus, or family) in a village was first calculated on its number in each of the 3 to 6 samples taken in the village. Then the mean densities in township-level were calculated according to the ones in village-level, and tabulated in sample site versus mean density.

Mean densities of *C. fumipennis* in township-level from the first-term survey were drawn (Table 1) to compute the following linear correlation and regression analysis: those obtained by the BLIV method were assigned as the dependent (Y), and those

by the sweep-net method, the independent (X). A chi-square goodness-of-fit test was conducted between the observed Y and their estimates resulted from corresponding equation.

Table 1. Mean densities of *Cephus fumipennis* in township-level, with samples taken by the two methods in wheat fields along the Valley of Huangshui River, Qinghai Province, China, in mid-June 1994

Sample site		Mean density, with samples taken by	
County	Township	BLIV [indiv./m^2]	Sweep-net [indiv./50 nets or indiv./33 m^2]
Minhe	Chuankou	0.00	0.00
	Machangyuan	0.00	–
	Songshu	0.20	2.50
	Hetaozhuang	0.33	–
	Li'erbu	1.00	0.00
Ledu	Hongshui	0.69	1.38
	Yurun	0.60	–
	Gaodian	0.00	–
Ping'an	Xiaoxia	0.40	–
Huangzhong	Dayuan	1.40	7.50
	Zongzhai	2.20	6.28
	Duoba	0.00	0.40
Datong	Houzihe	1.50	3.00
	Shuobei	10.60	51.50
	Liangjiao	17.60	76.40
	Chengguan	15.50	68.60
Huzhu	Wufeng	5.80	19.86
	Weiyuan	1.17	1.50
	Shuangshu	0.00	0.60
	Shatangchuan	0.83	0.40
Huangyuan	Heping	6.40	13.00
	Chengjiao	3.00	27.20
	Shenzhong	6.25	15.80
	Dongxia	3.75	9.30

RESULTS

Mean densities of *C. fumipennis* in township-level from the first-term survey were listed in Table 1, with many data for other insects omitted.

The linear correlation and regression analysis indicated: $\hat{y} = 0.664 + 0.214x$, $r = 0.966$ ($p < 0.001$, $n = 19$), meaning that there was a close relationship between the two sampling methods; $\chi^2 = 10.1$, meaning that the fit of the estimates with their observed Y was accepted at $p > 0.90$ ($\beta < 0.10$) (Fig. 1).

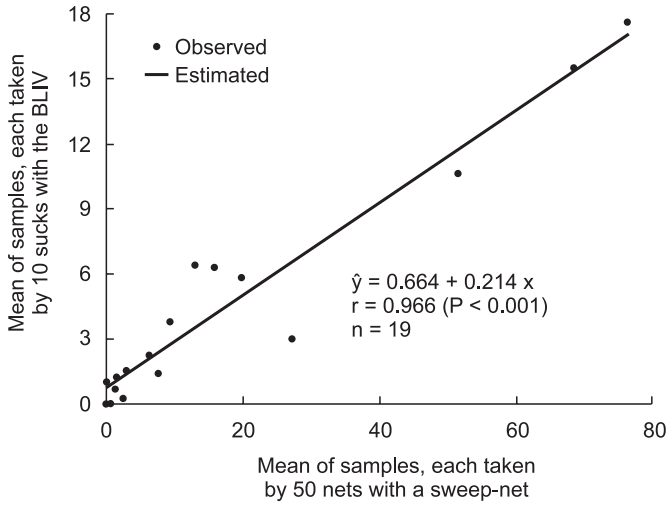

Fig. 1. Quantitative relationship between sampling *Cephus fumipennis* adults by the BLIV method (*Y*) and by the conventional sweep-net method (*X*)

DISCUSSION

The survey revealed the population abundance of many mobile insects in wheat fields, especially showed that *C. fumipennis* occurred all over the counties surveyed, relatively richer in Datong, Huangyuan, Huzhu, and Huangzhong, and lower in Minhe, Ledu, and Ping'an during the period the sampling was made (Table 1).

The comparison between the two sampling methods showed that taking samples with the BLIV method was able to obtain more species and higher numbers in a unit area, say 1 m^2, than doing with the sweep-net method, which meant that the former was able to reflect more complete messages of insect population densities in wheat fields than the latter.

The quantitative relation between the two sampling methods on *C. fumipennis* has connected a method of relative measures of density with an absolute one together. When the adult number by 50 nets is multiplied by the slope (0.214) of the linear equation, the product is approximately 11 nets, meaning that the absolute density of mobile adults per square meter could be similar to the average number of adults in 11-sweep-net samples taken randomly across the canopy of wheat plants during their flight.

It is known that the conventional sweep-net sampling method belongs to the category of relative measures of density (Elkinton 1993). Its advantage is easy to use and able to provide a qualitative detection of insects existing in fields; but unfortunately it cannot make any quantitative measures. The BLIV method belongs to the category of absolute measures of density. When being used, it is able to overcome the disadvantage of the sweep-net method, and afford quantitative data from one's field biological research regardless of inverse weather conditions; but it needs higher energy to carry and use, which is its disadvantage. The empirical relationship between them ought to be convenient to apply in the future for density monitoring of *C. fumipennis*, so as to make the sampling work in the pest's IPM effective and profitable.

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REFERENCES

Antonova V.P. 1965**.** The character of harmful fauna formation in grain crops in the Limans of Trans-Volga. Protection of Grain Cultures against Insect Pests in Staple Regions. Annals of Entomological Society of Soviet Union 50, 252: 240–271.

Dovnar-Zapolskij D.P. 1931**.** Study on Cephidae (*Hymenoptera, Chalastogastra*) (Part I). Annals of Zoological Museum. Academia of Sciences of Soviet Union, Leningrad 32, p. 45.

Elkinton J.S. 1993. Insect Population Ecology – an African Perspective. ICIPE Science Press. Nairobi, Kenya, 99 pp.

Eversmann E. 1847. Hymenopterous fauna in Volga-Ural regions – Hymenopterous species in provinces Volgam and Fluvium between mounts Uralenses with observations not described before. Bul. Soc. Nat. Moscow 20, p. 65.

Gussakovskij V.V. 1935**.** Faune de l'URSS, Ins. Hym. Chalastogastra 2, p. 116, 359.

Maa T.C. 1949. A synopsis of Chinese sawflies of the superfamily *Cephoidea* (*Hymenoptera*). Chin. J. Zool. 3: 17–42.

(QGESA) Qinghai General Extension Station for Agrotechniques. 2000. Disease and insect pests of wheat – the wheat stem sawfly. http://www.qhsjyagri.gov.cn

Stroganova V.K. 1976. New and little known species of the family *Cephidae* (*Hymenoptera*) in the fauna of West Siberia [*Calameuta bicornes*, *Trachelus pallipes*, *Cephus fumipennis*], p. 168–174. In "Novosti fauny Sibiri, USSR" (A.I. Cherepanov, ed.).

(XCRTWSS) Xunhua Cooperative Research Team on Wheat Stem Sawfly (by Peihe Xu). 1980. Preliminary study of the wheat stem sawfly (*Cephus* sp.). Science and Technology of Qinghai Agriculture and Forestry 6: 7–13.

Xu P.H., Yang R.K. 1984. Studies on occurrence pattern and control measures of the wheat stem sawfly (*Cephus* sp.) (1980–1982). Qinghai Academy of Agriculture and Forestry, 36 pp.

Zhao L.M. 2000. Identification of the natural resistance of several spring wheat varieties to *Cephus fumipennis* Eversmann. Acta Agriculturae Boreali-occidentalis Sinica 9 (2): 39–40.

Zhao L.M. 2005. *Cephus fumipennis* Ev. (*Hym.: Cephidae*): Morphology, biology and quantitative relations with wheat crop. Ph. D. Thesis. Warsaw Agricultural University, Poland, 133 pp.

Zhao L.M. 2006. *Cephus fumipennis* Ev. (*Hym.: Cephidae*): morfologia, biologia i ilościowe powiązania z pszenicą. http://bazy.opi.org.pl/raporty/opisy/synaba/126000/sn126940.htm

Zhao L.M., Jia H., Zhao L.X. 1996. Back-loaded insect vacuum. Bulletin of Practical and New Type Patent 12 (21), p. 7. (Beijing: China Patent Bureau).

Zhao L.M., Xu P.H., Du X.L., Jia H., Hou S.Y. 1994. Study on the sample size of larval gray-winged wheat stem sawfly, *Cephus fumipennis* Eversmann. Science and Technology of Qinghai Agriculture and Forestry 1: 23–26.

Zhao L.M., Du X.L., Jia H., Wang A.L., Hou S.Y., Gao J. 1997. Effect of *Cephus fumipennis* Eversmann on grain weight of different spring wheat varieties. Plant Prot. 23: 15–16.

Zhao L.M., Du X.L., Jia H., Wang A.L., Hou S.Y., Zhang Z.M., Gao J., Gan S.K, Zhao C.S. 1995. Preliminary result of the back-loaded insect vacuum used in the research on wheat insect regionalization. p. 108–113. In "The Progress of the Plant Protection Researches". Chinese Scientific and Technological Press, Beijing, China.

Zhu X.S., Wang F.C. 1959. Handbook for Controlling Insect Pests of Wheat Crops (I). Scientific Press, Beijing, China: 13–15.

POLISH SUMMARY

ILOŚCIOWE ZALEŻNOŚCI POMIĘDZY BEZWZGLĘDNYMI I WZGLĘDNYMI MIARAMI ZAGĘSZCZENIA POPULACJI *CEPHUS FUMIPENNIS*

Cephus fumipennis Eversmann należy do głównych gatunków szkodników obniżających plony pszenicy w prowincji Qinghai, w Chinach. Wykorzystano dwie metody określenia zagęszczenia jego populacji w warunkach polowych przy pomocy: plecakowego ekshaustora ciśnieniowego i standardowego czerpaka entomologicznego. Obliczono średnie wartości pomiarów dla poszczególnych gmin i zależności pomiędzy nimi jako: $\tilde{y} = 0.664 + 0.214x$. Wyznaczone empiryczne zależności powinny być wykorzystane w monitoringu zagęszczenia populacji źdźbłarza jako podstawy programu integrowanej ochrony roślin.