NOTE

Sweep Net Catches of Stink Bugs (Hemiptera: Pentatomidae) in Florida Rice Fields at Different Times of Day[1]

Ron Cherry and Chris Deren

Everglades Research and Education Center, P.O. Box 8003, Belle Glade, FL 33430 USA

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Rice, *Oryza sativa* L., is an important crop grown in the Everglades Agricultural Area of southern Florida with 7600 ha in production in 1998. Although many different insects are found in rice fields in the area, stink bugs are the most important pest. Jones and Cherry (1986. J. Econ. Entomol. 79: 1226-1229) reported the relative abundance and seasonal occurrence of stink bugs in southern Florida rice based on extensive surveys. In their study, the rice stink bug, *Oebalus pugnax* (F.), was the dominant species comprising >95% of all stink bugs. *Oebalus pugnax* is a major insect pest of rice found in all-rice growing areas of the eastern United States. Another stink bug pest of rice, *O. ypsilongriseus* (DeGeer), was first observed in Florida rice fields in 1994. In surveys conducted during 1995 and 1996, *O. ypsilongriseus* was found to be widespread in Florida rice fields being found in 100% of the fields surveyed (Cherry et al. 1998. Florida Entomol. 81: 216-220). *Oebalus ypsilongriseus* is a known pest of rice (Kashino and Alves 1994. Relatoria technica do projeto nipo-brasileiro de cooperacao em pesquida agricolo 1987/1992. Planaltina, Brazil.) and occurs in several Latin American countries (Pentoja et al. 1995. J. Entomol. Sci. 30: 463-467). Currently, the two species of *Oebalus* stink bugs are the main insect pest complex attacking Florida rice and comprise >99% of all stink bugs in Florida rice fields (Cherry et al. 1998).

Sweep nets have been widely used to sample insect populations including rice stink bugs. For example, sweep net samples are commonly used in scouting to determine economic damage levels for rice stink bugs (i.e., Jones et al. 1995. Fact Sheet AGR-94. Agronomy Department, U. Of Florida, Gainesville, FL). Also, sweep net samples are used in research studies on rice stink bugs such as insecticidal evaluations (Bowling 1962. J. Econ. Entomol. 55: 648-651) and damage evaluations (Harper et al. 1993. J. Econ. Entomol. 86: 1250-1258). Currently, Florida rice growers scout fields with sweep nets to determine economic damage levels for stink bugs. However, the effectiveness of sweep nets for estimating insect populations may be affected by different factors such as wind, temperature, etc. (See Southwood 1980.

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Ecological methods. Chapman and Hall. NY). Recently, Florida rice growers have questioned the effect of time of day on their sweep net catches in scouting programs. Currently, no data have been published on the effect of time of day on sweep net catches of *O. pugnax* in Florida or *O. ypsilongriseus* anywhere. Hence, our objective was to determine the effect of time of day on sweep net catches of the two *Oebalus* species. These data are useful in understanding the biology of these two important pests and also to determine a possible sampling bias in sweep net catches for these insects.

Twelve commercial rice fields in the Everglades Agricultural Area were sampled each year with sweep nets (38.1-cm diam) during the 1997 and 1998 growing seasons. Fields were sampled from July to November and each field was approximately 16 ha. Each field was sampled once at rice heading since this is the time both stink bug species increase rapidly in Florida rice fields (Jones and Cherry 1986, Cherry et al. 1998). Fields which had been sprayed with insecticides and contained few stink bugs were not sampled.

Stratified random sampling was used in each field since one of the species, *O. pugnax,* is known to have an aggregated distribution in Florida rice (Foster et al. 1989. J. Econ. Entomol. 82: 507-509). Eighteen flags were placed in a line at one end of each field with each flag being 5 m apart. These flags were divided into six strata with each three adjacent flags being one stratum, i.e., the first three flags equal stratum one, the next three flags equal stratum two, etc. One sweep net sample was taken at one flag from each strata at 0900, 1300, and 1700 h in one field during one day. Each sweep net sample consisted of 100 sweeps with one 180-degree horizontal stroke with the net in either direction being one sweep. One sweep was made with each forward step.

The possibility of differences in collecting efficiency among sweepers (Cochran et al. 1975. J. Econ. Entomol. 68: 563-564) biasing samples was eliminated by using the same people on any one day, and each person took the same number of samples in each of the three time periods. Sweepers went straight into the field for 50 m before starting in order to avoid possible edge effects (Douglas 1939. J. Econ. Entomol. 33: 300-303) and, thereafter, proceeded to take 100 sweeps straight across the field. This arrangement guaranteed that samples could be taken in the same stratum at the different time periods without samples overlapping. Hence, there were a total of 18 one hundred sweep samples taken in a field on a particular day, with six samples from each of the three time periods. Air temperatures and wind speed were recorded at each sampling period at a field's edge using a digital anemometer-thermometer (Control Company, Friendswood, Texas). Air temperatures were recorded 1 m above ground in the shade and wind speed was recorded 2 m above ground. Sampling was not conducted during rainy or stormy weather for the safety of sweepers (i.e., lightning strikes) and because rain and wind knock stink bugs off of rice plants (Douglas 1939). Data from the 24 fields sampled were pooled and Tukey's test (SAS 1997. SAS Institute Inc. Cary, NC) was used to determine mean differences in nymphs, adults, and total number of each species between the three time periods. Regression analysis (SAS 1997) was also used to determine linear correlations in each field between the total number of stink bugs of each species in a sample versus the air temperature and wind speed at the time the sample was taken.

The number of stink bugs collected in sweep nets at different times of the day in 24 Florida rice fields during 1997 and 1998 is shown in Table 1. There was no significant difference in mean numbers of nymphs, adults, or total number of *O.*

Table 1. Mean number of stink bugs caught in sweep nets at different times of the day in Florida rice fields during 1997 and 1998

	*O. pugnax**			*O. ypsilongriseus**			
Time	Nymph	Adult	Total	Nymph	Adult	Total	Overall total
0900	13.0	52.8	65.8	1.7	16.2	17.9	83.7
1300	9.8	54.6	64.4	1.8	10.9	12.7	77.1
1700	11.5	44.2	55.7	2.3	13.6	15.9	71.6

* Mean bugs per 100 sweeps. Means within a column are not significantly different (alpha = 0.05) using Tukey's test (SAS 1997).

pugnax caught at 0900, 1300, or 1700 h. Similar results were observed for *O. ypsilongriseus* and for overall total stink bugs (both species combined). Vertical movement on plants has been observed in *Oebalus,* and it is possible that this vertical movement may affect sweep net catches. For example, Franqui et al. (1988. J. Agric. Univ. P.R. 72: 365-369) reported that *O. ypsilongriseus* in Puerto Rico were observed on the lower parts of plants near the soil surface during the early morning and moved to the upper parts of plants during the day. In contrast, Dale (1994. Pages 363 to 487. *In* Biology and management of rice insects. E.A. Heinrichs (Ed.) John Wiley and Sons. NY) noted that in the Dominican Republic, *O. ornata* (Sailor) were very active on panicles during morning hours and moved to the base of the plant when the day became hotter. Consistent with our Florida data, Douglas (1939) reported finding no significant difference in the number of *O. pugnax* caught in sweep nets at different times of the day, but the area where these studies were conducted was not given. Differences in these studies are probably due to behavioral differences between stink bug species, different climates, and/or the condition of rice fields since little vertical movement would be expected in flooded rice as in Florida versus upland rice where a stink bug may actually move to the plant base or soil.

Besides changes in the vertical distribution of the species being studied, sweep net catches have also been shown to be influenced by weather conditions such as air temperature and wind speed (Southwood 1980). Air temperatures and wind speed data collected at different times of the day in Florida rice fields are given in Table 2.

Table 2. Mean air temperature and wind speed in Florida rice fields at different times of the day

	Time		
	0900	1300	1700
Air temperature*	25.5 (18-28)	30.5 (25-38)	29.3 (26-36)
Wind speed**	4.3 (1-11)	7.3 (1-22)	8.8 (1-28)

* Mean air temperature = °C. Numbers in parentheses = range. Data from 24 fields sampled 1997-98.
** Mean wind speed = km/h. Numbers in parentheses = range. Data from 24 fields sampled 1997-98.

Air temperature and wind speed were lowest in the morning (0900 h). The low wind speed observed at 0900 h is reflected in the tendency of southern Florida growers to apply aerial sprays of pesticides at this time to reduce aerial drift. Air temperatures and wind speeds at 1300 h and 1700 h were similar to each other. Although mean air temperatures and wind speed were different at the three times, these differences did not significantly affect sweep net catches of stink bugs at the three different sampling periods (Table 1). Regression analysis showed that in most fields there was no significant linear correlation (alpha = 0.05) between stink bug catches of either species versus air temperature or wind speed. These data show that air temperature and wind speed had little, if any effect, on stink bug catches under the conditions of our study.

In summary, our data show that under the range of weather conditions that we sampled, which excluded rainy, stormy, or very windy conditions, time of day is not a significant factor in sweep net catches of *O. pugnax* or *O. ypsilongriseus* in Florida rice fields. Also, air temperature and wind speed generally had little, if any effect on stink bug catches in sweep nets. These data should be useful to Florida rice growers who currently use sweep nets to monitor stink bug populations to determine economic damage levels.

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