An Example of Aggregation in the *Scaphinotus* Subgenus *Brennus* Motschulsky

(Coleoptera: Carabidae: Cychrini)

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On June 20, 1975, while collecting on the shores of Nicasio Reservoir, northern Marin County, California, Paul Choate and I encountered an extremely large aggregation of beetles referable to genus *Scaphinotus* subgenus *Brennus*. Some details relating to this event appear to be of biological significance and therefore worth reporting here.

While working up a low, open grassy knoll about 50m from the water, we found a large, partially-embedded oak log (approximate diameter 60cm, length 2.5m) with much of its bark intact. Soil under the log was slightly moist, but otherwise the area was quite dry. With considerable effort we rolled the log, just at dusk, and quickly collected a few individuals on the ground and underside of the log. Slow removal of the bark revealed several more individuals as well as the hollow interior of the log. Even in the dim light and without flashlights, we could see that the entire inner cavity was packed with beetles. We began collecting these individuals as total darkness approached, quickly filled all our collecting vials, then resorted to stuffing the beetles alive into our clothing. We noted that all individuals were very sluggish, slow to react to disturbance, at a time when these nocturnal animals would be expected to begin heightened activity. Only after several minutes were individuals roused to movement. Eventually many individuals escaped into the grass as we collected; but a larger number remained in the log when we could no longer see to collect.

Together, we collected over 130 specimens from the log; and I was surprised to find that three species were represented in the collection: *Scaphinotus interruptus* Menetries, *S. striatopunctatus* (Chaudoir), and *S. ventricosus* Dejean. If, conservatively, 30 percent of the massed individuals escaped capture, then the aggregation contained about 200 individuals. The significance of this large number can only be appreciated by comparison with the usual collection pattern. For example, a *good* day of collecting in suitable habitat might yield 10 to 20 of these large, conspicuous beetles if every rock and log over an area of perhaps 5000 to 10000 square meters were turned. While such a crude method of sampling may not reliably estimate or even reflect population densities in these beetles, and although no actual data on population densities in these species exist, it seems reasonable to

The Pan-Pacific Entomologist 53:27-31. January 1977

assume that the numbers of individuals in the aggregation represented substantial percentages of the populations normally ranging over a much greater area, perhaps over many thousand square meters. Relative numbers of individuals collected representing each species were roughly the same as would be expected through hand-collecting in the manner discussed above. Individuals of *S. interruptus* are at least twice as commonly collected as those of each of the other two species. In my material, relative numbers were as follows: 46 *S. interruptus* (21♂♂:25♀♀); 22 *S. striatopunctatus* (11♂♂:11♀♀); and 13 *ventricosus* (5♂♂:8♀♀). Choate collected 25 *S. interruptus* and about the same number for the other two species combined.

A few observations on aggregation in *Scaphinotus* species appear in the North American literature; but these report aggregations of relatively small size and single species. Nicolay (1913) found individuals of *S. (Irichroa) viduus* Dejean clustered together under loose bark at the base of a tree in the Catskill Mountains of New York. Pratt (1938) found 17 *S. (Stenocantharis) angusticollis* (Mannerheim) individuals together under adjacent boards on Whidby Island, Washington in May 1938; and I have found (unpublished field observations) numerous equivalent aggregations of members of this species in western Washington. Greene (1975) found repeated small aggregations of *S. (Pseudonomaretus) manni* Wickham individuals under the same stone during April and/or May, 1971 and 1973 in southeastern Washington. Two more impressive but unpublished accounts can also be mentioned here. R.T. Bell (personal communication) discovered an aggregation of 47 *S. (Brennus) marginatus* (Fischer von Waldheim) individuals in a single log in early July, 1973 near Corvallis, Oregon; and G. E. Ball (personal communication) similarly found 75 individuals, a mixture of *S. marginatus* and *S. angusticollis,* together in late July or early August, 1955 in southwestern British Columbia.

In comparison to previous observations, the aggregation Choate and I discovered appears to have been relatively large and unusual in its multi-species composition. Several questions concerning this massing of individuals immediately come to mind. How did this large aggregation form? What were the beetles doing there and how long might they have stayed *en masse?* Why were three species represented? Assuming that this particular aggregation was not unique, and that at least some level of aggregation occurs with some frequency in these species, what biological significance can we attribute to the phenomenon? Although data which might rigorously support answers to these and other questions are lacking, a brief discussion here may provide some tentative answers and, hopefully, stimulate others to begin ecological and populational studies on these fascinating animals.

Three possible mechanisms by which the aggregation could have formed are: (1) independent, individual response to an environmental gradient (or gradients) leading to aggregation in an environmentally (abiotically) optimum location; (2) individual response to some stimulus (or stimuli) provided by other individuals, leading to aggregation at a common location; or (3) a combination of the first two. The third choice seems most likely with (1) and (2) involved (in that order) sequentially. *Scaphinotus* beetles are usually found in cool, moist conditions and, in late June, such suitable areas are limited and isolated. I assume that the beetles normally follow moisture and temperature gradients in seeking suitable areas and that this common search would bring individuals together. At Nicasio Reservoir, however, much suitable cover exists in the form of large logs along the shores and ridges. A search of the area uncovered, in addition to the large aggregation, a few scattered individuals and aggregations of two to four individuals. From my casual observations, the log containing the large aggregation was in no way unique (in the microhabitat it provided or in its location) in proportion to the uniqueness of the aggregation it contained. Therefore, it seems unlikely that mechanism (1) alone can account for this aggregation.

Greene (1975), citing the work of Wautier (1971) on *Brachinus* spp., implied that the repeated aggregations he observed in *S. manni* may have formed in response to an "attractive odor" present at the aggregation site. *Scaphinotus* beetles are easily recognized by their very strong, omnipresent odor; and individuals of many species all seem to have the same odor. The source of the volatile chemical(s) detected is probably the pygidial defense gland. Beetles kept alive in culture maintain this distinctive scent even when left undisturbed, and their cages retain the same odor even after the beetles have been removed. Further observations of individuals in culture and in the field indicate a strong preference for close physical contact among individuals. I suggest that individuals are attracted to each other, probably through response to the defensive secretion. The influence of some special sex pheromone seems less likely because equal numbers of males and females were collected for all species. Once individuals make contact, their association is reinforced by positive tactile response. As the size of the aggregation increases, the *collective odor* of the mass should serve as an increasingly more powerful attractant to unassociated individuals (further augmenting the aggregation) and repellent to potential predators (see Greenslade, 1963).

S. interruptus, *S. striatopunctatus*, and *S. ventricosus* are the only cychrine species which occupy the oak woodland/savannah habitats around Nicasio Reservoir. Because relative numbers of individuals of each species collected from the aggregation reflected relative numbers normally obtained by hand-collecting in the area, the site appears to have functioned as a simple aggregation point for available individuals independent of their species identity. Although Gidaspow (1968), in her revision of subgenus *Brennus*, did not explore or even discuss phylogenetic relationships among these species, they appear to be quite closely related. Perhaps their respective defensive chemicals are structurally similar or identical, thereby permitting shared positive responses and the resultant multi-specific aggregation.

From several lines of evidence, these three *Brennus* species appear to be similar in life cycle timing to each other and to the five cychrine species Greene (1975) studied. The phenology outlined here summarizes my own field observations and collections over the past ten years and additional data associated with specimens in the California Academy of Sciences collections. In the San Francisco Bay area, larvae of these species are collected in December through May, teneral adults in March through June. Fully-pigmented adults appear to be most active in late Spring (April and May) and again in Autumn (late September through November), with irregular activity in Winter and early Spring and no apparent activity during the hot, dry Summer (June through early September).

As mentioned above, the beetles were immobile and unresponsive to considerable agitation when discovered. Both seasonal timing of the event and behavior of the beetles suggest a Summer diapause, aestivation, for these three species, with release from diapause coincident with the return of more favorable Autumn conditions [but possibly triggered by change in photoperiod (see Thiele, 1969)]. Dissociation of the aggregation seen would then have been expected in Autumn with the resumption of adult activity.

The following timetable for various adult activities in these species seems to fit the combination of observations and suppositions presented above. Adults emerge from the pupal stage in early Spring and feed while conditions remain favorable. Coincident with warming and drying trends, adults seek suitable aestivation sites with approaching Summer. Individuals may be aided in this search by their attraction to groups of other individuals already occupying large suitable sites. Aggregation may then be viewed as an aid to adult survival through the Summer. Maturation in both sexes probably takes place during the aestivation period (see also Greene, 1975). In Autumn, resumed activity includes mating and oviposition as well as locomotion and dissociation of the aggregation. Aggregation prior to aestivation may well aid in mating success by concentrating individuals of both sexes in a limited area subsequent to the feeding period (avoiding intensified competition for food) and prior to the mating period.

Acknowledgments

I thank P. H. Arnaud, Jr., D. C. Rentz, E. J. Zhovreboff, R. C. Drewes, N. E. Bronstein, and Beverly Kavanaugh for their careful reading and helpful criticism of the manuscript.

Literature Cited

Gidaspow, T. 1968. A revision of the ground beetles belonging to *Scaphinotus*, subgenus *Brennus* (Coleoptera, Carabidae). Bull. Amer. Mus. Nat. Hist., 140:135-192.

Greene, A. 1975. Biology of the five species of Cychrini (Coleoptera: Carabidae) in the steppe region of southeastern Washington. Melanderia, 19:1-43.

Greenslade, P. J. M. 1963. Further notes on aggregation in Carabidae (Coleoptera), with especial reference to *Nebria brevicollis* (F.). Entomol. Mon. Mag., 99:109-114.

Nicolay, A. S. 1913. [In] Proceedings of the Brooklyn Entomological Society. Bull. Brooklyn Entomol. Soc., 8:78.

Pratt, R. Y. 1938. One hour's collecting of *Scaphinotus* on Whidby. Pan-Pacific Entomol., 14:167.

Thiele, H.-U. 1969. The control of larval hibernation and of adult aestivation in the carabid beetles *Nebria brevicollis* F. and *Patrobus atrorufus* Stroem. Oecologia, 2:347-361.

Wautier, V. 1971. Un phénomène social chez les Coléoptères: les grégarisme des *Brachinus* (Caraboidea Brachinidae). Insectes Sociaux, 18:1-84.

ZOOLOGICAL NOMENCLATURE

The following Opinions have been published recently by the International Commission on Zoological Nomenclature, ITZN 59.

Opinion No. 1055 (Bull. zool. Nom. 33 (1) page 11) *Gryllus hieroglyphicus* Johannes Mueller (Physiologist) 1826 (Insecta: Orthoptera): suppressed under plenary powers in favour of *Decticus hieroglyphicus* Klug, 1832.

Opinion No. 1058 (Bull. zool. Nom. 33 (1) page 22) *Papilio actaeon* Fabricius, 1775 (Lepidoptera) suppressed under plenary powers in favour of *Papilio acteon* von Rottemburg, 1775.

Opinion No. 1062 (Bull. zool. Nom. 33 (1) page 31) *Anobium* Fabricius, 1775: *Grynobius* Thomson, 1859: *Priobium* Motschulsky, 1845 (Coleoptera) designation as type-species of *Ptinus punctatus* de Geer, 1774, *Anobium excavatum* Kugelann, 1791, and *Anobium carpini* Herbst, 1793, respectively.

Opinion No. 1064 (Bull. zool. Nom. 33 (1) page 36) *Ptenura* Templeton, 1844: *crystallina, Podura,* Muller, 1776 (Collembola) suppressed under plenary powers in favour of *Heteromurus margaritarius* Wankel, 1860.

The Commission cannot supply separates of Opinions.