

Tables 4 (group centroids) and 5 show five more or less distinct groups: 1. *L. unifasciatus* that overlaps the two following groups, 2. *L. unifasciatus* × *L. "tubero-interruptus"* and *L. "tubero-interruptus"*, 3. *L. unifasciatus* × *L. nigriceps*, 4. *L. nigriceps*, and 5. *L. nigriceps* × *L. "tubero-interruptus"*, *L. tuberum* and *L. "tubero-interruptus"* × *L. tuberum*.

Although not a primary goal of this study we will briefly comment on how to discriminate between the species using the characters for workers presented here (Table 6). Only one species, *L. nigriceps*, is clearly separated from all the other including the hybrids. Apart from *L. nigriceps* a dark area on femora is found only in the hybrid with *L. unifasciatus* which has a dark gaster band (extensive dark area in *L. nigriceps* not formed as a band). A faint femoral melanism was also found in some hybrids with *L. "tubero-interruptus"*. *L. unifasciatus* is usually a characteristic species distinguished by its sharply delimited gaster band. Sometimes (in some populations) this band is more diffuse with a tendency to become interrupted in the middle thereby approaching the condition in *L. "tubero-interruptus"*. This similarity with *L. "tubero-interruptus"* might be due to introgression from the latter species since seven of the eight colonies of *L. unifasciatus* that were classified as either *L. unifasciatus* × *L. "tubero-interruptus"* or *L. "tubero-interruptus"* (Table 5) are from loc. 7, where all but one *L. unifasciatus* × *L. "tubero-interruptus"* were found (Table 7). *L. "tubero-interruptus"* differs from *L. tuberum* which has a darker head and a very diffuse dark area on gaster in contrast to the more or less marked, interrupted band in *L. "tubero-interruptus"*. *L. tuberum* cannot be separated from its supposed hybrid with *L. "tubero-interruptus"* nor from *L. nigriceps* × *L. "tubero-interruptus"*.

## Discussion

From the morphological and electrophoretic analyses of our samples collected in South Sweden and Central and South Germany we conclude that there are four species in the *L. tuberum* group in Europe N of the Alps and W of approx. 15°. The distribution of these species is roughly as follows. *L. tuberum* is common in the north but rare in the southern parts. *L. unifasciatus* is the predominating species in the south (the most abundant species in 14 out of the 17 localities in Germany). *L. nigriceps* has a similar distribution but is less abundant. *L. "tubero-interruptus"* seems to be restricted to warm sites like the Rhine, Main and Tauber valleys (FISCHER 1987), and limestone areas (SEIFERT, pers. comm.; this study).

All four species occur in open to semi-open ground, *L. nigriceps* having a preference for more exposed sites than the other species (SEIFERT 1984, own obs.). The nests of *L. nigriceps* are found between stones and in rock crevices and this species is therefore confined to rocky/stony places. The other three species, especially *L. "tubero-interruptus"*, also inhabit dead wood (FISCHER 1987; SEIFERT, pers. comm.; own obs.).

At least three of the species, *L. unifasciatus*, *L. "tubero-interruptus"* and *L. nigriceps* interbreed. One of the hybrids, *L. unifasciatus* × *L. nigriceps*, can be identified on morphological grounds alone. So far, however, only three hybrid colonies have been reported (SEIFERT 1984; this study) suggesting that these species, frequently found together in the same habitat, rarely hybridize. Hybrid sexuals are produced (SEIFERT 1984), but it is not known if they are fertile. In any case, there is no evidence of gene flow from *L. unifasciatus* to *L. nigriceps*, since MDH-1 M (common in *L. unifasciatus*) was not found in *L. nigriceps*. Gene flow in the other direction might occur as indicated by the morphologically intermediate colony that was not an F<sub>1</sub> hybrid.

Although *L. nigriceps* × *L. "tubero-interruptus"* is distinct from its parents it is morphologically indistinguishable from *L. tuberum* (in the worker caste) and hence cannot be identified unless allozymes, karyotype or queen morphology is examined. The hybrid *L. "tubero-interruptus"* of FISCHER (1987) that he described as having slightly darker workers than pure *L. "tubero-interruptus"* is evidently *L. nigriceps* × *L. "tubero-interruptus"* as he