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BEES FOR POLLINATION

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BEES FOR POLLINATION

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Rasmont, P.,
THE FAUNISTIC DRIFT OF APOIDEA IN BELGIUM


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ABSTRACT
The authors studied the faunistic drift in Apoidea of Belgium by comparing the relative number of species before and 1950 onwards. The change in the abundance was estimated by the Stroot & Depiereux (1989) method. On 360 species, 91 are decreasing (25,2%), 145 are stable (40,2%), 39 are expanding (10,8%), and 85 have an indeterminable status (rare species: 23,5%). This regression cannot be attributed to a lack of observations as they are more numerous in the second period. The authors compare different hypotheses that could explain this global regression. As the most important one affects species with a long tongue, it is likely due to the fall in availability of plants with long corollae (e.g. Lamiaceae, Fabaceae, Scrophulariaceae). The strong relative regression of cleptoparasites could be seen as the result of an absolute numerical decrease of all Apoidea. The relative regression of species nesting in ground could be the evidence of the lacking availability or suitability of open areas through afforestation, urbanization or agricultural intensification. The regression which strongly affects long tongue species seriously threatens the maintain of an appropriate pollination level of wild and cultivated plants.

INTRODUCTION
Among the Apoidea, only bumblebees were subjected to a quantitative estimation of the faunistic drift (Williams et al., 1991) and this, just in two European areas: Great Britain (Williams, 1985, 1986), Belgium and North of France (Rasmont, 1988; Rasmont & Mersch, 1988). An estimation of this faunistic drift for solitary bees is so missing.

Leclercq et al. (1980) points out 13 species of Apoidea among the ones that make up their "first red list of threatened insects in the Belgian fauna". However, the method used then
to determine the status of the populations of these species does not include the abundance criterion. This short list is just the outcome of the consideration of the geographical spreading of taxa. A species was added to this "first red list" only if the number of occupied 10 km UTM squares since 1950 indicates a regression of 10 units in relation with the number of squares occupied before this year. This criterion allowed the useful determination of the 13 most threatened species. Nonetheless, the examination of old documents and the comparison of entomologists' recollections indicate that the Apoidea entomofauna has been much more deeply modified. Very often, the regression of a species isn't marked by a heavy fall in its distribution but by a decrease in its relative frequency.

Moreover, something can be added: the fact that a great part of the fauna is decreasing while another one is expanding can be seen as quite normal. The regression and expansion phenomena could be just the expression of a random variation of the fauna. Therefore, it is very important to study not only the geographical distribution but also the numerical variations of the species: the faunistic drift.

By "faunistic drift" we mean any modification of the relative specific composition of local faunae along time. This change is, in general but not always, linked to variations in the geographical distribution of species. "Faunistic drift" is a locution which has the advantage of being presumptively neutral, unlike the words "expansion" or "regression". Moreover, it reminds, by analogy with "genetic drift", that a great part of the population changes estimation can be stochastic or comes out of a sampling bias.

Thanks to a recent update of the Gembloux and Mons faunistic data bank, an estimation of the faunistic drift of Apoidea in Belgium can be provided.

**MATERIAL AND METHODS**

The Gembloux faunistic data bank has encoded all the data concerning Apoidea of Belgium, Luxembourg, the North of France and neighbouring areas till 1988. Since then, the University of Mons-Hainaut is also taking part in this collection of information.

The data are managed by the Microbanque faunique 2.0 (Rasmont & Barbier, 1991) software.

For Belgium alone, 48,654 data on 79,765 solitary bees specimens of the 1900-1991 period are now available. The main authors of these data are: J.Leclercq, A.Jacob-Remacle, A.Pauly, V.Lefeber, P.Mathot, J.Petit, K.Janssens, C.Thirion, L.Verleysen and P.Rasmont. The other authors are (in decreasing order of contribution) K.Warncke,

Only data including at least the year and the province are taken into account.

<table>
<thead>
<tr>
<th>Origin of data</th>
<th>before 1900 or without date</th>
<th>before 1950</th>
<th>since 1950</th>
</tr>
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<tr>
<td>field</td>
<td>9</td>
<td>3</td>
<td>1.214</td>
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<td>litterature</td>
<td>1.583</td>
<td>1.495</td>
<td>728</td>
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<tr>
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<td>12.573</td>
<td>63.752</td>
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<tr>
<td>Total number of specimens</td>
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<td>14.071</td>
<td>65.694</td>
</tr>
<tr>
<td>Data of the present study</td>
<td></td>
<td></td>
<td>79.765</td>
</tr>
</tbody>
</table>

**Table I.** Solitary Apoidea studied

All distribution maps of solitary bees of Belgium were published from 1971 to 1982 (Jacob-Remacle, 1982; Leclercq & Rasmont, 1985; Leclercq, 1971, 1972a,b, 1982; Liongo li Enkulu, 1982; Mathot, 1982; Pauly, 1978, 1982a,b,c). Those of Apidae Bombinae were published by Rasmont (1988).

We use the Stroot & Depiereux (1989) method to estimate the faunistic drift. This method is very attractive as it puts forward an objective estimation criterion which takes into account differences of sampling effort during the different periods.

For bumblebees (Apidae Bombinae), the data of Rasmont & Mersch (1988) are reinterpreted thanks to the Stroot & Depiereux (1989) method. However, the estimation criterion for this family is the number of specimens in collection and not the number of occurrences.
The faunistic drift of Apoidea in Belgium

<table>
<thead>
<tr>
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</thead>
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<tr>
<td>litterature</td>
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</tr>
<tr>
<td>collection</td>
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<td>12.282</td>
</tr>
<tr>
<td>Total number</td>
<td>78.937</td>
<td>14.890</td>
</tr>
</tbody>
</table>

* all specimens are not yet encoded but they have been all identified and counted.

**Table II.** Apidae Bombinae data from Rasmont & Mersch, 1988

The *Apis mellifera* (L.) case has not at all been considered here as it is known in Belgium just as a domestic insect. Therefore, Apidae include here bumblebees (Bombinae) only.

The data cover is detailed in the tables I and II. The survey seems to have been comprehensive for both periods (fig.1), except for the West-Vlaanderen province and the Gent surroundings.

For each species, the status calculated by the Stroot & Depiereux (1989) method is compared with the distribution map of the species. This lead first to the correction of the status of most species determined as "significantly" (*) or "highly significantly decreasing" (**) then, to the conclusion that they are "more or less stable". Are particularly concerned the species which are very confined and whose number of occupied UTM squares did not decrease nor increase by more than 25% (apparently stable distribution). The explanation of this systematic bias is that because of the sharp increase in the total number of occurrences for the second period, such a stability has been computed as a relative regression.

In the opposite, all species in significant (*) or highly significant (**) expansion actually indicate a distinct increase in the number of occupied UTM squares (more than 25% increase).

Incontestably all species computed as very highly significantly decreasing or increasing (***) present respectively a sharp regression or expansion. (at least 25% of difference in the observed UTM squares number).
Table III. Estimating faunistic drift using the Stroot & Depiereux (1989) method

<table>
<thead>
<tr>
<th>species</th>
<th>observed estimator</th>
<th>expected estimator</th>
<th>chi²</th>
<th>trend</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>before 1950</td>
<td>since 1950</td>
<td>TOTAL</td>
<td>before 1950</td>
</tr>
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<td>p₁₁</td>
<td>p₁₂</td>
<td>T₁.</td>
<td>e₁₁</td>
</tr>
<tr>
<td>species 2</td>
<td>p₂₁</td>
<td>p₂₂</td>
<td>T₂.</td>
<td>e₂₁</td>
</tr>
<tr>
<td>species 3</td>
<td>p₃₁</td>
<td>p₃₂</td>
<td>T₃.</td>
<td>e₃₁</td>
</tr>
<tr>
<td>species i</td>
<td>pᵢ₁</td>
<td>pᵢ₂</td>
<td>Tᵢ.</td>
<td>eᵢ₁</td>
</tr>
<tr>
<td>TOTAL</td>
<td>T₁.</td>
<td>T₂.</td>
<td>T</td>
<td>T₁.</td>
</tr>
</tbody>
</table>

Expected estimator

\[ E_{ij} = \frac{T_i \times T_j}{T} \]

\[
I_i = \sum_{j=1}^{2} \frac{(p_{ij} - e_{ij})^2}{e_{ij}}
\]

The value Iᵢ is compared with the value of chi² distribution (1 d° of freedom).
- : species in relative regression
= : species in relative status quo
+ : species in relative expansion
() : species with an expected estimator < 5 for the "since" period.
For the present study, the population estimators are
- occurrences by UTM(10km) * year, for the solitary Apoidea;
- number of specimens, for the bumblebees.

Figure 1. Solitary Apoidea of Belgium; covering of the survey 1.III.1992
(B: localisation of Brussels)

RESULTS

330 species of solitary Apoidea are observed in Belgium for the 1900-1992 period. Rasmont & Mersch (1988) point out for the same period 30 species of bumblebees. The detailed list of taxa is annexed.

On the 360 Apoid species known in Belgium for the studied period, 91 are decreasing (25.2%), 145 are more or less stable (40.2%), 39 are expanding (10.8%), and 85 are in an undetermined situation (rare species: 23.5%) (fig.2).
DISCUSSION

The present study confirms the status of the 13 species pointed as decreasing by Leclercq et al. (1980).

For solitary bees, the relative regression of species cannot be explained by a shortage in the observations (14,071 specimens before 1950 and 65,694 since 1950).

Besides, the regression rate of bumblebees is probably a bit overestimated (19 taxa in regression on 28 studied: 68%). According to Rasmont (1988) and Rasmont & Mersch (1988), the regression is less pronounced than following the present criteria (14 taxa in regression on 28: 50%) (table IV).
The regression is not equal for the different taxa (fig. 3).

The regression is sharp for Apidae and Anthophoridae (species with a long tongue preferring zygomorphic flowers with a long corolla): the number of decreasing species is prevailing and is far more greater than the number of stable or expanding ones. The regression is also sharp for Megachilidae (medium to long tongue): almost 25% of species are decreasing. However, almost 50% of the species are stable.

For Halictidae (short tongue), the regression is sharper than the expansion. Above all, however the majority of species are stable.
For Andrenidae and Colletidae (very short to short tongue), many species are stable and the number of increasing species is greater than the number of decreasing ones. In Melittidae (7 taxa with short tongue) and Rasmont & Mersch (1988), species are stable, except *Macropis europaea* which is distinctly decreasing (this has already been noticed by Leclercq et al., 1980).

![Status of Belgian Apoidea Foraging species](image)

**Figure 3.**

It seems so that the foraging taxa with a long tongue show a relative decrease particularly in comparison with species with a short one. The latter seem to be more or less stable or even in a relative small increase. The number of decreasing species is smaller than the number of increasing ones but the most important fact is that the stable species have a clear majority. This appears clearly in fig.4 where taxa have been gathered in three categories: species with a medium to a long tongue, species with a very short to a short tongue, and cleptoparasitic species.

This leads us to believe that the Apoidea regression is due first of all to the loss of floral resources which would be particularly marked for plants with long corollae (Fabaceae, Lamiaceae, Scrophulariaceae, Boraginaceae). Rasmont (1988) and Rasmont & Mersch (1988) have already noticed that the decrease of legume crops (Fabaceae) seems enough to explain the regression of most bumblebees species in Belgium (table V). The study of the data on the other wild Apoidea confirms this hypothesis. It must be added the excessive maintenance and erasing of embankments, side roads and public areas, which
are privileged locations for Lamiaceae (e.g. *Lamium* spp., *Ballota nigra*) and Boraginaceae (e.g. *Echium vulgare*, *Symphytum officinale*).
The very sharp regression of most of cleptoparasitic species (fig.5) is noticed too, especially in Megachilidae and Anthophoridae. This is curious since Anthophoridae parasite especially Andrenidae and Colletidae, taxa with short tongue, stable or in relative increase. The only hypothesis that could be put forward to explain this cleptoparasites regression is that it probably expresses an absolute numerical decrease of the hosts. Indeed, the survival of a cleptoparasitic species needs that the populations of its host are numerous. In case of a numerical regression of the host, even if its geographical distribution is not affected, its cleptoparasitic species would undergo a more than proportional decrease. Besides the relative regression of the long tongue species, an absolute regression of whole Apoidea superfamily must be feared.

<table>
<thead>
<tr>
<th>Table V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivated area of legumes in Belgium</td>
</tr>
<tr>
<td>(thousands ha)</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Alfalfa (Medicago sativa)</td>
</tr>
<tr>
<td>Clovers (Trifolium spp.)</td>
</tr>
<tr>
<td>Sainfoin (Onobrychis viciifolia)</td>
</tr>
<tr>
<td>Pea (Pisum sativum) and bean (Vicia faba)</td>
</tr>
<tr>
<td>Total area</td>
</tr>
</tbody>
</table>

Some nesting habits (listed by Westrich, 1990) seem to be correlated to the regression (fig.6). The few Belgian species nesting in snail shells are not worth discussing here as their number is too small. Species with nests in ground holes seem to be more threatened than the ones nesting in wood or plant stems, what had already been noticed by Westrich (1989). Michener (1979) point out that the nidification in ground holes would be an adaptation to open or xeric areas. In the opposite, species which are nesting in wood or in plant stems are rather adapted to woody or wet environments, as the nesting out of the ground avoids a great part of the mortality due to cryptogamic diseases in wet conditions. This relative regression of ground nesting species can be interpreted as a increasing lack of the availability or suitability of the open areas. Several mechanisms can be relied on this: afforestation, which was very important in some areas of Belgium (particularly in the province of Namur, where the greatest part of chalkland grasses, formerly used for cattle is now planted with pine woods); weeding of crops; conversion of lands into housing areas.

Among the factors whose role is difficult to estimate, the one of insecticides, herbicides and fungicides seems to be particularly problematic. The acute poisoning does not seem to have played a big role apart from local and limited cases. However, nearly nothing is known about the chronic intoxication and the influence of sublethal doses. The latter
could have brought selective pressure variations in different ways. As generations of wild bees are short, small interspecific differences in the selective pressure could have led in few years to the replacement of sensitive species by others.

Figure 6.
The conclusions of this study strongly remind those of Corbet et al. (1991), Osborne et al. (1991) and Williams et al. (1991), whereas these authors studied especially the case of the honey bee and bumblebees (Apidae). So it seems that the regression phenomenon of Apidae affects all kinds of wild bees too. Even short tongue species seem to undergo a regression despite their relative number increases. The whole regression phenomenon affects more strongly species with a long tongue. This must be considered as being serious as they are the most efficient and specialised pollinators. In an untouched wild bee fauna, the isolated regression of a long tongue species could probably be ecologically compensated thanks to the spontaneous substitution of competing species. However, in the present situation, it is the whole guild which is threatened. Therefore, we can fear that the linked regression of species will not allow a spontaneous replacement. It is likely that the density and the diversity of these pollinators fall under the population level needed to insure the pollination requirement of many agricultural and horticultural productions.
There is another big danger: the regression of key species would lead to the disappearance of great parts of the wild flora.

Very few European countries have a long tradition to collect and study Apoidea. It is therefore unlikely that a long and constant survey - as in Belgium - could become widespread in the whole Europe. However, the progressive dying out of legume crops, breeding intensification, afforestation of agricultural areas economically marginal and urbanization are general in Europe. Therefore, this faunistic drift of the Apoidea fauna should also appears everywhere.

**CONCLUSIONS**

On 360 species observed in Belgium since 1900, 25% are decreasing and only 11% are expanding. This regression especially affects long tongue species, which are precious specialised pollinators, auxiliaries of agriculture and horticulture. This can be seen as the result of the dying out of legume crops and of the destruction of wild long corolla flowers like labiate, borage and figwort families.

The strong relative regression of cleptoparasites can be seen as the outcome of an absolute numerical decrease of the whole Apoidea superfamily.

The relative regression of the species nesting in ground holes can be interpreted as a consequence of a lacking availability or suitability of open areas through afforestation, urbanization and agriculture intensification.

The general wild bees regression, which strongly affects long tongue species, seriously threatens the maintain of an adequate pollinating level of wild and cultivated plants.
REFERENCES


Annex

List of solitary bee of Belgium
observed during the period 1900-1992
and estimation of their status

Nesting habits :
- g = nest in ground hole
- w = nest in wood
- p = nest in plant stem
- h = nest in snail shell

<table>
<thead>
<tr>
<th>Nest</th>
<th>Species</th>
<th>Number of Occurrences</th>
<th>Observed</th>
<th>Expected</th>
<th>Chi²</th>
<th>Corrected Trend</th>
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</thead>
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<tr>
<td>g</td>
<td>Anthophora aestivalis Schenck</td>
<td>g</td>
<td>24</td>
<td>7</td>
<td>55.63</td>
<td>- ***</td>
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<td>g</td>
<td>Anthophora bimaculata (Panzer)</td>
<td>g</td>
<td>23</td>
<td>8</td>
<td>36.53</td>
<td>- ***</td>
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<td>g</td>
<td>Anthophora furcata (Panzer)</td>
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<td>56</td>
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<td>54.53</td>
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<td>104</td>
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<td>76.02</td>
<td>+ ***</td>
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<td>g</td>
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<td>23</td>
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<td>p</td>
<td>Eucera nigrescens Pérez (= tuberculata)</td>
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<td>2</td>
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<table>
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<td>39</td>
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<td>w</td>
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<td>63</td>
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<td>w</td>
<td>30</td>
<td>45</td>
<td>6.92</td>
<td>+ **</td>
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<tr>
<td>w</td>
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<td>11</td>
<td>12</td>
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<td>1</td>
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<td>19</td>
<td>17.43</td>
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<td>4</td>
<td>22.37</td>
<td>- ***</td>
</tr>
<tr>
<td>w</td>
<td>Megachile lapponica Thomson</td>
<td>w</td>
<td>0</td>
<td>4</td>
<td>5.21</td>
<td>+ **</td>
</tr>
<tr>
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### Foraging Halictidae

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## Andrenidae (all foraging species)

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### Colletidae (all foraging species)

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### Cleptoparasitic Anthophoridiae

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TOTAL number of occurrences for the period since 1950: 19453
GRAND TOTAL: 27244

The present version is corrected and adapted to PDF format for Acrobat Reader 6.0.