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Chapter 4

Orchids and Orchid Bees of the Brownsberg, Nassau and Lely ranges

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SUMMARY

A total of 190 species of orchids have been recorded from the Brownsberg, Nassau and Lely ranges: 141 from Brownsberg, 70 from Nassau, and 96 from Lely; 16% are known from all three ranges, and 31% only from Brownsberg. The lower orchid richness figures for Lely and Nassau can be regarded as artifacts due to low collecting effort. Compared to other sites in the Guayana Shield region, Brownsberg has the second-highest recorded orchid species richness. The available information suggests that a number of orchid species that are very rare in the region occur at these three ranges, e.g. *Beloglottis costaricensis* (Brownsberg), *Cranichis diphylla* (Lely) and *Quekettia papillosa* (Nassau).

There was no significant difference between the three ranges (at $p < 0.05$; based on test of independence) in the proportion of species assigned to different elevation classes, but there were significant differences in the proportion of species assigned to different substrate classes. Lely with 16% ground and epilithic orchids diverges from the other two ranges, which each have 4-5% of such orchids. A high proportion of highland orchid species – ca. 30-40% – may be the characteristic that distinguishes these ranges with elevated plateaus from areas that are true lowlands, and may explain the high species richness. There may be a trend that highland orchids become more important as the height of the range's main plateau increases. This and the greater importance of ground and epilithic orchids at Lely suggests that Lely may be the most divergent, unique and species rich of the three ranges.

A total of 34 species of orchid bees was collected at the three ranges: 13 at Brownsberg, 22 near Lely and 23 at Nassau. The frequency of bees with orchid pollinaria differed significantly between Nassau and a lowland location near Lely. At the first location, none of the bees carried pollinaria, while at the second, the figure was 13% More sampling needs to be done before a detailed comparison of the bee faunas of the three ranges can be made. The high frequency of orchid bees with pollinaria at Nassau is unusual, and may be linked to the habitat in which most sampling took place: the low elevation cloud forest of the submontane plateau.

It is recommended that rapid orchid inventories of Nassau and Lely are undertaken, in which herbarium specimens are collected as well as live specimens. Data resulting from these inventories should be processed together with existing data in relation to the Brownsberg. More orchid bee samples must be obtained form all three ranges, and the relationship between orchids and orchid bees at these ranges should be investigated.

Special protection should be given to the submontane habitats (400 m and higher) at all three ranges, most urgently so at Lely; representative parts of the Nassau and Lely ranges require a degree of protection. The Brownsberg submontane zone where a mining concession is located also requires adequate protection.

INTRODUCTION

The Orchidaceae – the orchid family – is the largest family of flowering plants in the world, with at least 20,000 species worldwide and 7,000 in the Neotropics (see Roubik and Hanson

2004), which amounts to about ten percent of all flowering plant species. For the Guianas (Guyana, Suriname and French Guiana), a total number of 328 orchid species has been recorded, which makes the orchid family the second most species rich vascular plant family of the region (Clarke et al. 2001). More than 300 species of orchids have been recorded for Suriname (Werkhoven 1986). This global, regional and national importance of the orchid family justifies its inclusion in a rapid biological and conservation assessment (RAP) of the Brownsberg, Nassau and Lely ranges in Suriname.

Another reason to include the orchids in surveys is because of their public appeal and economic importance, as obvious from the countless popular publications on orchids, a worldwide network of orchid breeders and enthusiasts, and the global trade in ornamental orchids. In Suriname too, orchids are popular and valuable: there is an orchid association, orchids are traded each week-end in the capital Paramaribo, and orchids feature in the popular flower arrangements and bouquets that are for sale in downtown Paramaribo.

The name orchid bee has its origins in the fact that male Euglossinae are specialized pollinators of a number of orchid species, especially those belonging to the Stanhopeinae and Catasetinae (van der Pijl and Dodson 1966). These orchids provide neither nectar nor pollen to their visitors, but concentrated fragrant chemicals which only male orchid bees seem to be interested in. These male bees may also be the exclusive visitors of the flowers of other orchids, such as *Vanilla, Cyrtopodium*, and *Lycaste*. Euglossinae (male and female) in addition visit the flowers of e.g. *Sobralia* and *Maxillaria* (see van der Pijl and Dodson 1966 and Roubik and Hanson 2004). Based on the above and the orchid species listings by Werkhoven (1986) and Chiron and Bellone (2005), at least 20% of the regional orchid species may be pollinated by Euglossinae, while 10% may strictly depend on pollination by male Euglossinae. The males of virtually all of the Euglossinae in turn depend on the flowers of orchids and a few unrelated plant taxa as a source of fragrant chemicals that they appear to need to establish territoria and/or mate (Roubik and Hanson 2004). The exceptionally strong interdependency between these bees and many of the orchids justifies a joint assessment.

Euglossine bees and orchids may be regarded as indicators of rainforest bee and plant diversity in the Neoptropics because they are archetypical, diverse and abundant Neotropical forest bees that visit, pollinate, and depend on a great variety of plant species (see Roubik and Hanson 2004, who e.g. list 68 plant families visited). They are an ideal group to be used for rapid assessments, since simple techniques exist to quickly get substantial samples of orchid bees: the males can be lured to chemical baits, at which they are easily trapped or captured with nets (Ackerman 1989, Roubik and Hanson 2004).

The Brownsberg, Nassau and Lely ranges are part of a system of ranges with ferro-bauxite encrusted plateaus. Such ranges may cover less than 0.5% of Suriname's land surface and may constitute a rare and endangered landscape type (ter Steege et al. 2005; see also chapter on the Biodiversity of the Brownsberg). The Brownsberg is the only of these ranges that enjoys any kind of protection, but it is being damaged by illegal gold mining, and its main submontane plateau remains a mining exploration concession. Other ranges, like Nassau and Lely, also feature mining exploration concessions and illegal gold mining, currently without the benefit of any protection at all.

During the RAP field work at Lely and Nassau, no sampling of orchids or orchid bees was undertaken. Nevertheless, it will be attempted here to assess the orchid and orchid bee diversity of the Brownsberg, Nassau and Lely ranges, based on the currently available information. A quick scan of the information at hand indicated that it was quite incomplete and unbalanced, so the focus here will necessarily be on a very general characterization of the Orchidaceae and Euglossinae assemblages of these ranges. Obvious differences between the three ranges will be highlighted, and recommendations as to research and conservation will be made.

METHODS

Records of the occurrence of orchid species were obtained from:

- dried herbarium specimens in the National Herbarium of Suriname (BBS);
- the review of Suriname orchids by Werkhoven (1986);
- botanical inventories by Banki et al. (2003), and ter Steege et al. (2004, 2005);
- a Brownsberg orchid inventory by Jan den Held (pers. comm.);
- unpublished observations at Browsberg by the junior author (Molgo);
- live specimens collected at Nassau in 2006, in the care of the junior author.

Live orchids were identified using the reference specimens and the taxonomic literature available to the junior author. All orchid species names were checked and updated using Werkhoven (1986), Boggan et al. (1997), Chiron and Bellone (2005) and the Electronic Plant Information Centre of the Kew Royal Botanical Gardens (see www.kew.org/epic/ accessed July 2006.)

Records of the occurrence of orchid bee species were obtained by processing samples and (re)identifying specimens in the National Zoological Collection of Suriname (NZCS):

- samples / specimens from Brownsberg collected prior to 2006
- samples obtained at the main plateau of Nassau in 2006

- samples obtained along the Tapanahony River near Lely in 2006 (samples were obtained near Diitabiki (Drietabbetje), across the Tapanhony River near Lely, but strictly speaking not at Lely itself; however, the Tapanahony is not assumed to be a barrier for orchid bee dispersal).

At all three ranges, bees were collected with bottle traps placed upright on the forest soil. Bottle traps are white plastic bottles of ca. 1 l with one or several openings cut in the side; the traps are made operational by pouring ca. 5-25 CC of lure chemical in the bottle, as well as at least 100 CC killing / conservation fluid (either a ca. 2% formaldehyde solution in water or pure "coolant" – an ethylene glycol solution). The Brownsberg samples were collected using bottle traps with vanillin and cineole (eucalyptol) as lure chemicals; the Nassau and Tapanahony samples were obtained using vanillin, cineole, eugenol and methyl salicylate. At Tapanahony and Nassau, additional bee specimens were collected at baiting stations by means of an insect net. At each station lure chemicals were poured on toilet paper that was suspended in the vegetation (the four chemicals mentioned above were used, and in addition skatole and p-dimethoxy benzene).

Orchid bees were identified using the taxonomic literature available to the senior author (De Dijn), the images of orchid bees of French Guiana on the Discover Nature (2006) website, reference specimens received from Roubik and Oliveira, and digital images of type material provided by Roubik. Notes were made of bee specimens carrying orchid pollinaria (i.e. typical orchid pollen "containers" which get attached to the body or appendages of orchid flowers visitor pollinators; see Roubik and Hanson 2004).

To characterize the orchid assemblages of Brownsberg, Nassau and Lely, the orchids were classified in function of the elevation range at which they are known to occur elsewhere, and the natural substrate on which they occur. The orchid species recorded were assigned to one of three elevation classes, based on the information contained in Steyermark et al. (1995a, b; info based on observations in the Guayana Shield territories of Venezuela): i) Low – only known from locations below 400 m, ii) High – only known from elevations of at least 400 m, and iii) Low-High – known from locations below 400 m as well as 400 m or more. The species were also assigned to classes in function of substrate (based on Werkhoven (1986), Chiron and Bellone (2005) and Molgo pers. obs.): i) epiphytic orchids – growing mostly on the stems, branches or other above-ground parts of woody plants, and ii) ground and epilithic orchids – growing mostly in soil or on rocky substrates at ground level. Orchid species for which information on elevation or substrate was lacking were not used in statistical analyses.

To investigate eventual differences between the ranges in terms of the proportions of species known from different elevation ranges and different types of substrates, test of independence were performed, based on two-way (R x C) tables and calculation of the G-statistic, as in Sokal and Rohlf (1995: Box 17.8).

RESULTS

A total of 190 species of orchids have been recorded from the three ranges, with 141 species recorded from Brownsberg, 70 from Nassau, and 96 from Lely. A list of all the species and their recorded occurrence can be found in Appendix 4. The most species rich genera are *Pleurothallis* (20 species), *Maxillaria* (20), and *Epidendrum* (15); together they represent 39% of the recorded species.

Figure 4.1 illustrates the overlap in recorded orchid species between the Brownsberg, Nassau and Lely ranges; 16% of the species are known to occur at all three ranges; 31% of the species are only known for the Brownsberg.

Table 4.1 shows the number of recorded species that could be assigned to different elevation classes. Based on this table, a (3 x 3) test of independence was performed, which yielded G = 4.01 (below critical value χ^2 .05[4] = 9.48773), meaning that there was no significant difference between the three ranges (at $p < 0.05$) in the proportion of species assigned to different elevation classes. However, there may be a trend in the data, with the proportion of species assigned to the High elevation class increasing from Brownsberg (29%), over Nassau (33%) to Lely (42%).

Figure 4.2 shows the number of recorded species that could be assigned to different substrate classes. Based on these numbers, a (2 x 3) test of independence was performed, which yielded G = 9.57 (above critical value χ^2 .05[2] = 5.99), meaning that there were significant differences between the three ranges (at $p < 0.05$) in the proportion of species assigned to different substrate classes. Further tests of independence between all possible pairs of ranges (2 x 2 tests; test results not presented here) indicate that the difference in the above proportion is significant only between Lely and Brownsberg and Lely and Nassau, which means that

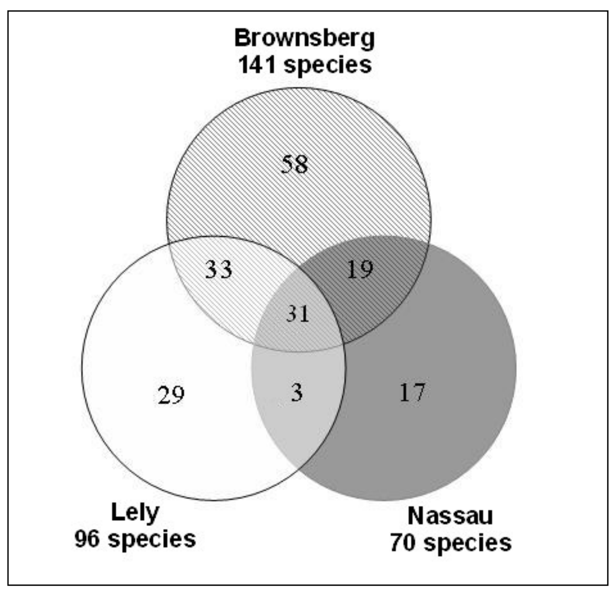

Figure 4.1. Overlap in orchid species composition between three ranges in Suriname.

Lely with 16% ground and epilithic orchids diverges from the other two, which each have 4-5% of such orchids.

Based on the list of recorded orchid species (Appendix 4), and the general information on orchid genera visited by orchid bees (see introduction), it can be concluded that: i) 10 of the orchid species (5%) at Brownsberg, Nassau and Lely are dependent on male orchid bees for pollination, and an additional 25 (13%) are probably pollinated by male and female orchid bees.

A total of 34 species of orchid bees was collected at the three ranges: 13 at Brownsberg, 22 near Lely and 23 at Nassau. The dominant genus was *Euglossa* (mostly small green or blue bees) with 27 species (Appendix 5).

The frequency of bees with orchid pollinaria was calculated on the basis of the bees collected at baiting stations with a net: near Lely 0 of 96 bees had pollinaria, at Nassau 9 of 69 bees. It is obvious that these frequencies are significantly different between the two sites. The bees with pollinaria were: *Euglossa analis* (2), *E. townsendi* (3), and *E. gaianii* (4); these three species represent 9% of the recorded bee species.

Two morphologically very different kinds of pollinaria (belonging to different orchid species; see examples in Roubik and Hanson 2004) were observed on these bees. A number of the bee individuals examined were carrying multiple pollinaria (as could also be observed in flight when the bees were attracted to the chemical baiting stations at Nassau; De Dijn pers. obs.).

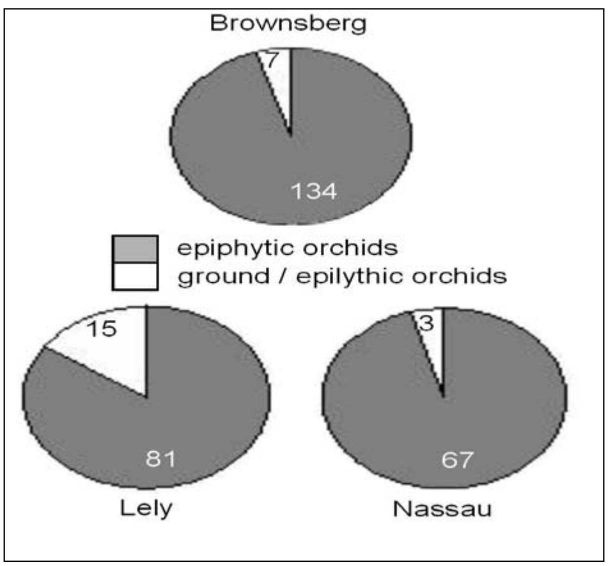

Figure 4.2. Number of orchid species recorded from three ranges in Suriname as a function of the substrate on which they usually grow in nature.

DISCUSSION

The high number of 141 species of orchids recorded at Brownsberg (almost half of the number of species known from Suriname) is no surprise, as this is the most accessible and by far the best investigated of the three ranges (see chapter on the Biodiversity of the Brownsberg). The lower orchid richness figures for Lely and Nassau can be regarded as artifacts of a lower collecting effort (Molgo and De Dijn pers. obs.). The limited overlap in species composition between the three ranges is surprising, given the great similarities in landscape and habitats; it may mean that many species are rare or hard to detect and collect, and that many more species remain to be recorded (at Nassau and Lely for sure, but possibly also at Brownsberg. Indeed, the unpublished Brownsberg orchid survey of den Held is relevant in this respect; when the survey data is transformed into a <randomized> species-effort curve, no obvious asymptote can be detected, suggesting that many more orchid species await discovery even at Brownsberg). When more collecting has been done at Nassau and Lely, the overlap in orchid species composition between the ranges can be investigated in earnest. The currently available information suggests that a number of orchid species that are very rare occur at these ranges, as for example the following species, each of which is only known from one location and from nowhere else in the Guianas: *Beloglottis costaricensis* (Brownsberg), *Cranichis diphylla* (Lely) and *Quekettia papillosa* (Nassau).

Using the Brownsberg orchid species richness result (141 species) as a yardstick, the comparison can be made with other well investigated sites in the region (based on listings in Bongers et al. 2001 and Clarke et al. 2001), such as: Saül (150 species) and Nouragues (68) in French Guyana, Kaieteur Falls (105) and Mabura Hill (109) in Guyana, and Reserva Ducke (79) in the Brazilian state of Amazonas. The Brownsberg is virtually on a par with Saül, these two sites having by far the highest recorded orchid species richness in the region. The low numbers for Reserva Ducke and Nouragues may be due to the fact that these are essentially

Table 4.1. Number orchid species recorded from three ranges in Suriname as a function of the elevation at which they are known to occur elsewhere.

Site (range)	Elevation class			Total no. of species
	Low below 400 m	Low-High below 400 m as well as 400 m or higher	High 400 m or higher	
Brownsberg	14	57	29	100
Nassau	9	23	16	48
Lely	7	28	26	61

lowland locations which lack extensive submontane habitats that seem to be particularly favorable for epiphytes, such as orchids (see also chapter on the Biodiversity of the Brownsberg). It should perhaps not be surprising that Saül and Brownsberg are so comparable in terms of orchid species richness: both areas are well sampled and contain an extensive submontane plateau with ferro-bauxite encrusted soil.

In the chapter on the Biodiversity of the Brownsberg (chapter 13), it is argued that 400 m is a useful cut-off point in the region under consideration, to distinguish between lowland and submontane habitats (in agreement with Steyermark et al. 1995a). Approximately 30-40% of the orchid species at the three ranges may be considered "highland" species, i.e. species that have been recorded in the Venezuelan Guayanas (where much research has been done) at 400 m of higher. Such a high proportion of highland species may be the characteristic that distinguishes these ranges with elevated plateaus from areas that are true lowlands, and may explain the high species richness: lowland and highland (submontane and montane) species coming together at these favorable locations. This would certainly merit further investigation, if alone to explain why the ranges in question may be orchid hot spots. In the Guianas, highland orchid species necessarily have a restricted, fragmented distribution, and may be rare; the submontane plateaus of Brownsberg, Nassau and Lely may be critical for the conservation of these species in the region.

The results on the proportions of ground and epilithic orchids, and of orchid species that are restricted to high elevations, suggest a trend and a quantum leap: i) a trend that the highland orchids become more important with the increase in height of the main plateau of the range, and ii) a much greater importance of ground and epilithic orchids at Lely, compared to the other two ranges. These matters would also merit further investigation, as they suggest that Lely may be the most divergent, unique and species rich of the three ranges. The special status of Lely is recognized by ter Steege and collaborators (2005), who mention the great extent of "moss forest" (low-elevation cloud forest with a high epiphyte load) with many orchids. Nassau should however not be underestimated as an orchid hot spot: in a single survey of less than three days (in 2006 by Molgo and De Dijn; unpublished), 32 species were recorded that were previously not known to occur at Nassau (including three species that were previously unknown from any of the three ranges).

The total number of orchid bees recorded from Brownsberg, Lely and Nassau is comparable to the total of 29 species collected at Bakhuis by means of bottle traps and four chemical lures (De Dijn in prep.). However, the number of species recorded at the different ranges is substantially lower (despite the use of six chemical lures at Nassau and near Lely), and suggests that at each range more sampling needs to be done; very little sampling has taken place at Brownsberg anyway. A detailed comparison of the bee faunas of the three ranges and other areas would not seem possible at this stage. It goes almost without mention that a reliable comparison will require that bee samples be taken at Lely proper, instead of nearby along the Tapanahony River.

The low frequency of orchid bees with pollinaria near Lely is unsurprising, but the high frequency (13 %) at Nassau is unusual, at least given figures of 1% and 5% quoted by Roubik and Hanson (2004). The high numbers of bees with orchid pollinaria at the main plateau of Nassau may be linked to the habitat and the timing of sampling: most of the sampling took place in low elevation cloud forest which is rich in orchids, and the timing of the sampling (April 2006) seemed to coincided with the flowering of a substantial number of orchids (Molgo and De Dijn pers. obs.).

The extent to which orchids and orchid bees actually interdepend at the community level remains a matter of discussion (see Roubik and Hanson 2004), and the data presented here suggests that: i) some 18% of the orchid species of Brownsberg, Nassau and Lely may be pollinated by orchid bees (some 5% exclusively so), and ii) that at least 9% of the orchid bee species may actually pollinate some of these orchids. While the former is in line with expectations (see introduction), the latter is less so (see Roubik and Hanson 2004, who conclude that about half of the species in an Euglossine assemblage carry pollinaria and pollinate orchids), and would seem to be an artifact of much too limited sampling and a total lack of observations of bees visiting orchid flowers at the three ranges under consideration.

RECOMMENDATIONS

It is recommended that rapid orchid inventories of Nassau and Lely are undertaken, in which herbarium specimens are collected as well as live specimens. The latter can be maintained alive in Paramaribo, at least until they produce flowering parts, which are essential to identify the species. Special attention should be given to the investigation of the habitats of highland species and ground and epilithic orchids. The data resulting from these inventories should be processed together with data of den Held in relation to the Brownsberg; collaboration with den Held should be sought to complete analyses. Based on the results, a more detailed comparison between the ranges would be possible, as well as a comparison with other ranges and lowland locations in the region. Based on the additional inventory data and flora comparisons, the status of regionally and nationally rare orchid species must be investigated, especially of those species that are at present only known from the three ranges. Habitats where rare orchids occur should be identified, and measures should be taken to protect them in their native habitats.

The relationship between orchids and orchid bees at these ranges requires further investigation, especially in relation to those orchid and bee species that can be assumed (based on the literature and the data presented above) to be interdependent. More orchid bee samples need to obtained during rapid assessments, at all three ranges (especially at Brownsberg and Lely), and notes should be made on the orchid pollinaria these bees are carrying. The unusually high frequency of orchid bees with pollinaria recorded at Nassau requires further investigation; there may be an especially significant interaction between orchid bees and orchids at these ranges, at least in special habitats such as low elevation cloud forest. This interaction may only be apparent when sampling or observations are done at specific times of the year, and if so, would require monitoring. Targeted studies of the pollination and seed set with rare orchids at these ranges may be required, e.g. to assess their level of dependency on specific pollinators and their vulnerability to local extinction.

Ahead of the results of proposed further assessment and monitoring studies, special protection should already be given at this stage to the submontane habitats (400 m and higher) at all of these ranges, most urgently so at Lely. Protection is required because: i) the very high orchid species richness of the ranges is no doubt due largely to the presence of highland orchid species in the submontane forest habitats these would seem to require, and ii) each of the ranges appears to be unique in terms of orchid species composition, e.g. at each range occurs at least one orchid species that is known from nowhere else in the Guianas. Lely would merit urgent conservation action because: i) it proves to have high numbers of highland orchid species and ground and epilithic orchids that may be associated with vulnerable submontane habitats, and ii) its submontane habitats are presumably pristine – due to poor accessibility – and characterized by a high degree of functional integrity that may however be negatively affected as soon as the area becomes more accessible, e.g. as a result of renewed mining exploration. Habitats other than submontane ones may also be important for orchids and orchid bees, and it would thus be sensible to work towards the protection of representative parts of the Nassau and Lely ranges, ensuring the protection of a substantial portion of all habitats. At Brownsberg some degree of protection is already in place, but the matter of the SURALCO mining concession that covers most of the submontane zone should be addressed soon, as this zone requires more adequate protection.

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Appendix 4

Preliminary checklist of the orchids (Orchidaceae) of the Brownsberg, Nassau, and Lely ranges in Suriname.

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The recorded occurrence of species at each range is indicated by highlighting in black in the Range column below the corresponding range identifier (B = Brownsberg, N = Nassau, and L = Lely). Ground & epilithic orchids are marked "G" and highlighted in black in the Substrate column; all others (not highlighted in this column) are epiphytic orchids (marked "E"). Orchids recorded below 400 m elevation in Venezuelan Guayana (see Steyermark et al. 1995b) are highlighted in black and marked "L" (for Lowland) in the Elevation column; those recorded at 400 m or higher are also highlighted but marked "H" (for Highland); if no species-specific data from Venezuelan Guayana was available, the Elevation column is not highlighted, and the elevation at which the species may occur is indicated between brackets (based on data of congeners in Steyermark et al. 1995b and / or notes on the occurrence of the species in French Guiana (Chiron and Bellone 2005) or Suriname (Werkhoven 1986)).

Orchid genera that are considered to produce fragrant chemicals only (no nectar) as a reward for pollinating male orchid bees (Euglossinae) are highlighted dark grey and underlined in the Genus column; orchid genera considered to produce nectar and visited by potentially pollinating male as well as female orchid bees are highlighted light grey.

Genus	Species	Range			Substrate	Elevation	
		B	N	L			
Acianthera	*fockei*	■			E	L	
Aganisia	*pulchella*	■	■	■	E		H
Aspidogyne	*foliosa*			■	G	(L)	(H)
Batemania	*colleyi*	■	■	■	E	L	
Beloglottis	*costaricensis*	■			G		(H)
Bollea	*violacea*	■	■		E	(L)	(H)
Brassia	*caudate*	■			E	L	H
Brassia	sp.			■	E	(L)	(H)
Bulbophyllum	*bracteolatum*			■	E	(L)	
Caluera	*surinamensis*	■			E	(L)	
Campylocentrum	*micranthum*	■		■	E	L	H
Catasetum	*cristatum*	■			E	L	H
Catasetum	*deltoideum*	■	■		E	(L)	(H)
Chaubardiella	*tigrina*	■			E		H
Cheiradenia	*cuspidata*	■	■		E	L	H
Cochleanthes	*guianensis*	■	■	■	E		H
Cranichis	*diphylla*			■	G		H

Genus	Species	Range			Substrate	Elevation	
		B	N	L			
Cryptarrhena	*guatemalensis*	■			E	(L)	(H)
Cryptarrhena	*kegelii*	■			E		H
Cyclopogon	*elatus*	■		■	G		H
Dichaea	*histrio*			■	E		(H)
Dichaea	*hookeri*	■	■	■	E	L	H
Dichaea	*muricata*	■		■	E		H
Dichaea	*picta*	■	■		E	L	H
Dichaea	*pumila*		■		E	(L)	(H)
Dichaea	*rendlei*			■	E	(L)	(H)
Dichaea	*trulla*	■	■	■	E	L	H
Dimerandra	*elegans*	■			E	L	
Dipteranthus	sp.	■			E		(H)
Elleanthus	*capitatus*	■		■	E	(L)	(H)
Elleanthus	*caravata*	■	■	■	E	L	H
Elleanthus	*graminifolius*	■	■	■	E		H
Encyclia	*ceratistes*	■		■	E	(L)	
Encyclia	*diurna*	■		■	E	L	
Encyclia	*granitica*			■	E	L	
Encyclia	*guianensis*	■			E	L	H
Epidendrum	*anceps*	■			E	L	H
Epidendrum	*desiflorum*	■			E		H
Epidendrum	*difforme*		■		E	(L)	
Epidendrum	*microphyllum*	■			E	(L)	
Epidendrum	*nocturnum*	■	■	■	E	L	H
Epidendrum	*paniculatum*		■		E	(L)	(H)
Epidendrum	*purpurascens*	■	■	■	E	(L)	(H)
Epidendrum	*ramosum*	■	■	■	E		H
Epidendrum	*rigidum*	■			E	L	H
Epidendrum	*secundum*	■			E	L	
Epidendrum	sp. 1	■			E	(L)	(H)
Epidendrum	sp. 2	■			E	(L)	(H)
Epidendrum	*strobiliferum*	■			E	L	H
Epidendrum	*strobiloides*	■	■	■	E	L	H
Epidendrum	*unguiculatum*	■		■	E	L	H
Eriopsis	*biloba*	■		■	E	L	H
Erycina	*pusilla*	■	■	■	E	L	H
Erythrodes	sp.	■		■	G		(H)
Gongora	*histrionica*	■			E	(L)	(H)
Gongora	*pleiochroma*		■		E	L	

Genus	Species	Range			Substrate	Elevation	
		B	N	L			
Habenaria	*alterosula*			■	G	(H)	(H)
Ionopsis	*satyrioides*	■		■	E	L	H
Ionopsis	*utricularioides*	■			E	L	H
Isochilus	*linearis*	■		■	E		H
Jacquiniella	*globosa*	■	■	■	E		H
Jacquiniella	*teretifolia*	■		■	E		H
Kefersteinia	*lafontainei*	■	■	■	E	(L)	(H)
Kegeliella	*houtteana*	■		■	E	(L)	(H)
Koellensteinia	*carraoensis*		■	■	G		H
Koellensteinia	*hyacinthoides*		■		E	L	
Koellensteinia	*kellneriana*		■		E		(H)
Lepanthes	*helicocephala*	■		■	E	L	
Lepanthes	*ruscifolia*	■		■	E		(H)
Lepanthes	*wageneri*		■		E		(H)
Ligeophila	*stigmatoptera*			■	G		H
Ligeophila	cf. *umbraticola*			■	G		(H)
Liparis	*nervosa*		■		G	L	
Lockhartia	*imbricata*	■	■		E	L	H
Lophiaris	*lanceana*	■			E	(L)	
Lycaste	*macrophylla*	■			E		H
Lyroglossa	*grisebachii*	■			G	(L)	(H)
Macradenia	*lutescens*	■			E	L	H
Macroclinium	*wullschlaegelianum*	■		■	E	L	H
Malaxis	*excavata*			■	G		H
Masdevallia	*cuprea*	■		■	E	(L)	(H)
Masdevallia	*infracta*		■		E	(L)	(H)
Masdevallia	*minuta*	■	■		E	(L)	
Masdevallia	*norae*	■		■	E	L	H
Maxillaria	*alba*	■	■	■	E		H
Maxillaria	cf. *auyantepuiensis*		■	■	E		H
Maxillaria	*brunnea*	■			E		H
Maxillaria	*caespitifica*			■	E	(L)	(H)
Maxillaria	*camaridii*	■	■		E	L	
Maxillaria	*christobalensis*	■			E		(H)
Maxillaria	*crassifolia*	■	■		E	(L)	
Maxillaria	*desvauxiana*	■	■	■	E	L	H
Maxillaria	*discolor*	■	■		E	L	H
Maxillaria	*jenischiana*	■		■	E		(H)
Maxillaria	*ochroleuca*		■		E		H

Genus	Species	Range			Substrate	Elevation	
		B	N	L			
Maxillaria	*parkeri*			■	E	**L**	**H**
Maxillaria	*ponerantha*		■	■	E	(L)	(H)
Maxillaria	*reichenheimiana*	■	■	■	E		**H**
Maxillaria	*rufescens*	■	■	■	E	**L**	**H**
Maxillaria	*splendens*	■		■	E		**H**
Maxillaria	*stenophylla*	■		■	E		**H**
Maxillaria	*superflua*		■		E	**L**	
Maxillaria	*uncata*	■	■		E	**L**	**H**
Maxillaria	*violaceopunctata*	■			E	**L**	**H**
Mesadenella	*cuspidata*	■	■	■	**G**		(H)
Neolehmannia	sp.	■			E	(L)	(H)
Notylia	cf. *incurva*			■	E	(L)	(H)
Notylia	*sagittifera*	■			E		(H)
Notylia	sp 1	■			E	(L)	(H)
Notylia	sp. 2	■			E	(L)	(H)
Octomeria	*brevifolia*	■		■	E	(L)	(H)
Octomeria	*deltoglossa*			■	E	(L)	
Octomeria	*minor*			■	E	**L**	**H**
Octomeria	sp		■		E	(L)	(H)
Octomeria	*surinamenis*	■			E	**L**	**H**
Oncidium	*baueri*	■			E	**L**	
Ornithidium	*parviflorum*	■	■	■	E	**L**	**H**
Ornithocephalus	*cf. bicornis*	■			E	**L**	
Ornithocephalus	*gladiatus*	■			E	**L**	
Paphinia	*cristata*	■	■		E	**L**	**H**
Pelexia	*callifera*	■		■	**G**	**L**	**H**
Peristeria	*guttata*	■	■	■	E		**H**
Peristeria	*pendula*			■	E	**L**	**H**
Physurus	sp.			■	**G**		(H)
Platystele	*ovalifolia*	■		■	E	**L**	**H**
Platystele	*stenostachya*	■	■	■	E	(L)	(H)
Platythelys	*maculata*	■			**G**		(H)
Plectrophora	*iridifolia*	■			E	**L**	**H**
Pleurothallis	*archidiaconi*			■	E		**H**
Pleurothallis	*aristata*	■	■	■	E	**L**	**H**
Pleurothallis	*barbulata*	■		■	E	**L**	**H**
Pleurothallis	*ciliolate*	■			E	**L**	**H**
Pleurothallis	*determannii*	■			E	(L)	(H)
Pleurothallis	*discoidea*	■	■	■	E		(H)

Genus	Species	Range			Substrate	Elevation	
		B	N	L			
Pleurothallis	*glandulosa*	■		■	E	L	
Pleurothallis	*grobyi*	■	■		E	L	H
Pleurothallis	*lanceana*			■	E	L	
Pleurothallis	*monocardia*			■	E		(H)
Pleurothallis	*picta*	■			E	L	H
Pleurothallis	*polygonoides*	■			E	(L)	
Pleurothallis	*pruinosa*	■			E	L	H
Pleurothallis	*pubescens*			■	E		(H)
Pleurothallis	*ruscifolia*		■		E		H
Pleurothallis	*semperflorens*		■		E	(L)	
Pleurothallis	*seriata*	■			E		H
Pleurothallis	*spiculifera*	■	■	■	E	L	H
Pleurothallis	*suspensa*	■	■	■	E		H
Pleurothallis	*yauaperyensis*	■			E	L	H
Polystachya	*concreta*	■	■		E	L	H
Polystachya	sp.			■	E	(L)	(H)
Prescottia	*stachyodes*			■	G		H
Prosthechea	*aemula*	■	■	■	E	L	
Prosthechea	*calamaria*	■			E		H
Prosthechea	*pygmaea*	■		■	E		H
Prosthechea	*vespa*	■			E	L	H
Quekettia	*papillosa*		■		E	(L)	(H)
Quekettia	*vermeuleniana*	■		■	E	(L)	(H)
Reichenbachanthus	*reflexus*	■	■	■	E		H
Rodriguezia	*flavida*		■		E	(L)	
Rodriguezia	*lanceolata*	■	■		E	L	H
Sarcoglottis	*acaulis*			■	G	L	H
Sarcoglottis	*amazonica*			■	G	(L)	
Scaphyglottis	*dunstervillei*	■			E		H
Scaphyglottis	*fusiformis*	■		■	E	L	H
Scaphyglottis	*graminifolia*	■	■	■	E	L	H
Scaphyglottis	*lindeniana*	■		■	E		(H)
Scaphyglottis	*modesta*	■	■		E		H
Scaphyglottis	*prolifera*	■	■		E		H
Scuticaria	*steelii*	■			E	L	H
Sigmatostalix	*amazonica*	■	■		E	L	
Sobralia	*crocea*		■		E	(L)	(H)
Sobralia	*fimbriata*			■	E		H

Genus	Species	Range			Substrate	Elevation	
		B	N	L			
Sobralia	*fragrans*	■			E	L	H
Sobralia	*macrophylla*	■			E	L	H
Sobralia	*suaveolens*	■			E	L	H
<u>*Stanhopea*</u>	*grandiflora*	■			E	L	H
Stelis	*aprica*	■			E	L	H
Stelis	*argentata*	■	■	■	E	(L)	(H)
Trichocentrum	*fuscum*	■	■		E	L	H
Trichosalpinx	*foliata*	■			E		(H)
Trichosalpinx	*memor*	■		■	E		H
Trichosalpinx	*orbicularis*	■	■	■	E	L	H
Trigonidium	*acuminatum*	■		■	E	L	H
Trisetella	*triglochin*	■			E	L	H
<u>*Vanilla*</u>	cf. *odorata*	■	■		E	L	H
<u>*Vanilla*</u>	sp.			■	E	(L)	(H)
Wullschlaegelia	sp.			■	E	(L)	(H)
Xylobium	*foveatum*	■		■	E	(L)	(H)
Xylobium	*pallidiflorum*	■			E		H
Xylobium	*variegatum*	■			E		(H)

Appendix 5

Preliminary checklist of the orchid bees (Euglossinae) of the Brownsberg, Lely and Nassau ranges in Suriname.

Iwan E. Molgo and Bart P.E. De Dijn

Genus	Species	Brownsberg	near Lely[1]	Nassau
Eufriesea	*pulchra*		X	
Eufriesea	sp. 1	X		
Euglossa	*amazonica*		X	X
Euglossa	*analis*		X	X
Euglossa	*augaspis*		X	X
Euglossa	*chalybeata*	X	X	X
Euglossa	*chlorina*			X
Euglossa	*cognata*		X	X
Euglossa	*cordata*			X
Euglossa	*crassipunctata*	X		
Euglossa	cf. *deceptrix*		X	X
Euglossa	cf. *despecta*	X	X	
Euglossa	*gaianii*		X	X
Euglossa	*ignita*		X	X
Euglossa	*imperialis*	X	X	X
Euglossa	*intersecta*		X	X
Euglossa	*ioprosopa*			X
Euglossa	*iopyrrha*		X	
Euglossa	*magnipes*			X
Euglossa	*modestior*	X	X	X
Euglossa	*mourei*		X	
Euglossa	*orellana*			X
Euglossa	*piliventris*		X	X
Euglossa	cf. *prasina*			X
Euglossa	*retroviridis*		X	X
Euglossa	sp. 1	X		
Euglossa	*stilbonota*	X		X
Euglossa	*townsendi*	X	X	X
Euglossa	*tridentata*	X		
Eulaema	*meriana*	X	X	X
Eulaema	*mocsaryi*		X	

Genus	Species	Brownsberg	near Lely[1]	Nassau
Eulaema	*pseudocingulata*	X		
Exaerete	*frontalis*		X	X
Exaerete	*smaragdina*	X	X	
Total Number of species		**13**	**22**	**23**

[1]Samples were obtained near Diitabiki (Drietabbetje), across the Tapanhony river near Lely, but strictly speaking not at Lely itself; however, the Tapanahony is not assumed to be a barrier for orchid bee dispersal.