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# *Hemipilia avisoides* (Orchidaceae), a new species from Sichuan Province, China

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# 1 ***Hemipilia avisoides* (Orchidaceae), a new species**

## 2 **from Sichuan Province, China**

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## 12 **Abstract**

13 A new orchid species, *Hemipilia avisoides*, is described from Songpan County  
14 and Maoxian County, Sichuan Province, China. Morphologically, it is most  
15 similar to *H. occidensichuanensis* ( $\equiv$  *Ponerorchis limprichtii*), but *H. avisoides*  
16 can be distinguished by the combination of its involute middle lip lobe that is  
17 smaller than the lateral lobes, pendulous lateral lip lobes, floral bracts that are  
18 always shorter than the ovary, a leaf that is appressed to substrate and is  
19 adaxially green with white veins and a solitary sheath at the stem base. The  
20 floral morphology of *H. avisoides* is also presented by utilising *in vivo* micro-  
21 CT scanning and 3D visualisation.

## 22 **Keywords**

23 Arid alley, Minjiang River Valley, Orchidinae, taxonomy

## 24 **Introduction**

25 The genus *Hemipilia* Lindl. *sensu stricto* (Orchideae, Orchidaceae) comprises  
26 ca. 10 species that are characterised by a protruding, tongue-like rostellum  
27 (Luo & Chen 2000; Chen et al. 2009). Nevertheless, molecular phylogenies  
28 revealed *Hemipilia* s.s. as monophyletic, but nested deeply within a strongly-  
29 supported clade that also included several species from closely-allied genera,

30 for example, *Ponerorchis* Rchb. f., *Amitostigma* Schltr. and the monotypic  
31 *Hemipiliopsis* (K. Y. Lang) Y. B. Luo & S. C. Chen (Luo 1999; Bateman et al.  
32 2003; Jin et al. 2014, 2017; Tang et al. 2015). Given the fact that *Ponerorchis*  
33 and *Amitostigma* are paraphyletic, both Jin et al. (2014) and Tang et al. (2015)  
34 formally proposed to expand the circumscription of *Hemipilia*, although to a  
35 different extent. Here, we follow the treatment of *Hemipilia sensu latissimo*, in  
36 which seven sections were recognised (Tang et al. 2015).

37 During the field trip in 2013 to collect *A. physoceras* Schltr. in Minjiang  
38 River Valley, Songpan County, Sichuan Province, China, one of the authors  
39 (Y. Tang) collected another orchid that morphologically fits into the category of  
40 *Hemipilia s.l.* It had been temporarily identified as cf. *Ponerorchis limprichtii*  
41 (Schltr.) Soó in the previous study by Tang et al. (2015). However, this taxon  
42 in Songpan not only differs in the morphology of the labellum and leaf, but  
43 also diverges in DNA sequences, both of which suggest it as a potential new  
44 species (Tang et al. 2015). Here, we describe it in *H. sect. Hemipilia sensu*  
45 Tang et al. (2015) and present its floral morphology by utilising an *in vivo*  
46 micro-CT method.

## 47 **Methods**

### 48 **Material collection**

49 During our field investigation to Minjiang River Valley, Songpan, Sichuan,  
50 China in 7–9 June 2022, two populations of the new taxon with 12 flowering  
51 individuals were found. One population occurs at the same locality that was  
52 visited in 2013 by one of the authors (Y. Tang) and the other is ca. 11.2 km  
53 southwards in the Valley.

54 A total of four living individuals with intact flowers from the two  
55 populations were collected, each was packaged with soils and EPE pearl  
56 cotton in a plastic bottle and transported by air to the Key Laboratory of  
57 Stratigraphy and Paleontology, Ministry of Natural Resources for *in vivo*  
58 micro-CT scanning. After scanning, these individuals were pressed as  
59 specimens. The voucher specimens were deposited at the Herbarium of  
60 Sichuan University (SZ).

### 61 **Morphological observations**

62 The morphological description of the new taxon was mainly based on living  
63 materials. The length and width of leaves and the height of the inflorescence  
64 were measured on seven living, flowering plants in the field. The morphology

65 of subterranean parts was described on the four plants collected (see Material  
66 collection). The morphology of a single flower was described mainly on the  
67 basis of the 3D mesh model reconstructed by micro-CT data.

## 68 **Micro-CT scanning and 3D Visualisation**

69 X-ray Computed Tomography (CT) was completed at the Key Laboratory of  
70 Stratigraphy and Paleontology, Ministry of Natural Resources. One of the four  
71 living individuals collected (see Material collection) was finally selected for  
72 scanning and was then chosen as the holotype of the new taxon. Its  
73 inflorescence with the uppermost three flowers was scanned *in vivo* in a Nikon  
74 XTH 225ST CT scanner at a resolution of 18.6  $\mu\text{m}$  and X-ray of 90 kv and 70  
75  $\mu\text{A}$ .

76 3D reconstructions were performed in the software VGSTUDIO MAX 3.0  
77 with STL files being exported. For the 3D model of inflorescence, however,  
78 only the uppermost two flowers were reconstructed due to the trade-off  
79 between resolution and computing time. Acquired 3D mesh models were  
80 visualised and processed by the software GOM INSPECT PRO in GOM  
81 SUITE 3.1.1109.0.

## 82 **Results**

### 83 **Taxonomic treatment**

84 ***Hemipilia avisoides* Y. Tang, X. M. Wang & H. Peng, sp. nov.**

85 Figs. 1A–D, 2 and 3; see also Data availability

86 **Type. CHINA, Sichuan Province, Aba Tibetan and Qiang Autonomous**  
87 **Prefecture**, Songpan County, 9 June 2022, Y. Tang, X. M. Wang & Y. T. Zhu  
88 235 (holotype: SZ!); Songpan County, 9 June 2022, Y. Tang, X. M. Wang & Y.  
89 T. Zhu 236 (paratype: SZ!); Maoxian County, 1 June 1958, S. Y. Chen, Z. He,  
90 M. F. Zhong *et al.* 5078 (paratype: SZ!).

91 **Diagnosis.** Similar to *Hemipilia occidensichuanensis* Y. Tang & H. Peng  
92 ( $\equiv$  *Ponerorchis limprichtii* (Schltr.) Soó), from which *H. avisoides* can be  
93 distinguished by a set of characteristics: mid-lobe involute, suboblong in apical  
94 view, trapeziform when flattened, smaller than lateral lobes; lateral lobes  
95 pendulous; floral bracts 5 mm long, always shorter than ovary; leaf appressed  
96 to substrate, adaxially green with white veins; stem with one sheath at base  
97 (Fig. 1; Table 1).

98        **Description.** Terrestrial, erect herbs, 8.5–31 cm tall. Tubers oblong, 2.5  
99 cm long, 0.8 cm in diameter, neck with few roots. Stem subterranean, 2.7–5  
100 cm long, 0.2 cm in diameter, with one sheath at base. Sheath tubular,  
101 membranous, 1–2 cm long, pale yellow. Leaf appressed to substrate, solitary,  
102 cordate, ovate or elliptic, 3–6.5 × 2–5.5 cm, apex acute, slightly fleshy,  
103 glabrous, abaxially purple, adaxially green with white veins, occasionally also  
104 with purple spots. Inflorescence terminal, erect, 3–14 cm long, 1–21-flowered,  
105 glabrous, dark purple. Flowers not secund, plum or purple plum, fragrant;  
106 floral bracts connivent to ovary, elliptic, 5 × 2.6 mm, shorter than ovary, apex  
107 acuminate, glabrous, dark purple; ovary curved, cylindrical, 10.5 mm long  
108 including pedicel, 1 mm in diameter, glabrous, dark purple. Dorsal sepal erect,  
109 oblong, cymbiform, 4.5 × 2.6 mm, apex rounded, sometimes concave at each  
110 side of central vein below middle, glabrous; lateral sepals spreading, obliquely  
111 ovate, cymbiform, 5.6 × 3.6 mm, apex obtuse, glabrous. Petals erect,  
112 connivent with dorsal sepal and forming a hood, apex bending similar to  
113 holding a fist in the other hand, obliquely ovate, 4 × 2.8 mm, apex obtuse,  
114 glabrous. Labellum spreading, broadly ovate when flattened, 7.1 × 5.4 mm, 3-  
115 lobed below middle, spurred, base collar-like raised on each side of spur  
116 entrance, glabrous, tinged white at base, disc dotted with purple; lateral lobes  
117 pendulous, rhombic, 3.4 × 2.5 mm, apex truncate, margin slightly undulate;  
118 mid-lobe horizontal, involute, suboblong in apical view, 2.2 × 1.2 mm,  
119 trapeziform when flattened, apex rounded or sometimes apiculate; spur  
120 horizontal, straight or curved upwards, cuneate, 9 mm long, ventrally carinate  
121 along central axis, entrance 2.5 mm wide, apex swollen, obtuse, 2.7 mm wide;  
122 anther reclined, 2.8 mm long, 2-locular, locules parallel and closely spaced,  
123 aubergine; pollinia 2, sectile, ovate, 1.2 × 0.7 mm; caudicles cuneate, 1.2 mm  
124 long; viscidia 2, closely spaced, oblong, transparent, each enclosed within a  
125 separate bursicle; bursicles formed by folding of rostellar arms, oblong, 0.6 ×  
126 0.3 mm; rostellum median lobe triangle, 0.7 mm long, lateral lobes grooved;  
127 stigma ventral, lobes 2, divergent, lamelliform, 1.2 × 0.5 mm, with hairs at  
128 base; auricles 2, each placed laterally at base of anther, behind collar of  
129 labellum base, 0.5 mm long.

130        **Flowering.** Peaking in early June.

131        **Distribution and habitat.** *Hemipilia avisoides* is currently known from  
132 two localities in Songpan County, which are ca. 11.2 km apart along the  
133 Minjiang River Valley and one locality in Maoxian County according to the  
134 collection by S. Y. Chen et al. in 1958. Individuals of the new taxon occur  
135 under arid-valley shrubs and on moss-covered rocks (see Discussion).

136        **Etymology.** The epithet refers to the resemblance of flowers and

137 inflorescence of *Hemipilia avisoides* to wild geese that are flapping wings and  
138 flying in formation.

139 **Chinese name.** 雁字舌喙兰 (Chinese pinyin: yàn zì shé huì lán).

140 **Additional specimens examined.** *Hemipilia avisoides*: **CHINA, Sichuan**  
141 **Province, Aba Tibetan and Qiang Autonomous Prefecture**, Songpan  
142 County, 30 June 2013, Y. Tang 151 (KUN!).

143 *Hemipilia occidensichuanensis*: **CHINA, Sichuan Province, Ganzi**  
144 **Tibetan Autonomous Prefecture**, Kangding City, 18 June 2022, Y. Tang, X.  
145 M. Wang, W. Q. Yuan & Y. T. Zhu 237 (SZ!); Kangding City, 17 June 2017, Y.  
146 L. Peng, Q. Yu & L. L. Li THP-KD-1390 (CDBI!); Kangding City, 13 June 2014,  
147 Y. Tang 199 (KUN!); Luhuo County, 12 August 2005, D. E. Boufford, J. H.  
148 Chen, K. Fujikawa, S. L. Kelley, R. H. Ree, H. Sun, J. P. Yue, D. C. Zhang &  
149 Y. H. Zhang 34770 (A!); Xiangcheng County, 15 July 2004, D. E. Boufford, J.  
150 H. Chen, S. L. Kelley, J. Li, R. H. Ree, H. Sun, J. P. Yue & Y. H. Zhang 30764  
151 (A!); Daofu County, 10 June 1996, J. S. Yang 91-270 (IBSC!; PE!); Kangding  
152 City, 28 May 1981, Z. J. Zhao, J. B. Shi & D. G. Fan 114262 (SZ!); Xinlong  
153 County, 28 June 1974, Z. S. Qin 06383 (CDBI!); Xinlong County, 27 June  
154 1974, Z. S. Yu 06409 (CDBI!); Yajiang County, 15 June 1961, S. Jiang 05196  
155 (KUN!). **CHINA, Sichuan Province, Aba Tibetan and Qiang Autonomous**  
156 **Prefecture**, Xiaojin County, 21 May 1959, Xiao Jin Zu 0130 (SZ!); Xiaojin  
157 County, 21 May 1957, J. Zhou 34 (IBSC!); Maerkang City, 16 May 1957, X. Li  
158 71047 (PE!; SZ!). **CHINA, Gansu Province, Longnan City**, Wenxian County,  
159 12 May 2007, Bai Shui Jiang Cai Ji Dui 4839 (PE!); Wenxian County, 9 May  
160 2007, Bai Shui Jiang Cai Ji Dui 4514 (PE!); Wudu District, 15 June 1959, Z. Y.  
161 Zhang 4390 (WUK!); Wudu District, 5 June 1959, Z. Y. Zhang 3379 (WUK!);  
162 Wudu District, 30 May 1959, Z. Y. Zhang 3180 (PE!; WUK!). **CHINA, Gansu**  
163 **Province, Gannan Tibetan Autonomous Prefecture**, Zhouqu County, 27  
164 May 1999, Bailongjiang Exped. 1408 (PE!). **CHINA**, 1959, Chuan Jing A 0130  
165 (KUN!); July 1907, E. H. Wilson 1762 (specimen 2nd from left: AMES!).

166 **Conservation status.** *Hemipilia avisoides* seems narrowly distributed  
167 within the Arid valley in the upper reaches of Minjiang River (see Discussion),  
168 with few populations and individuals being found. The habitat of *H. avisoides*  
169 could be easily disturbed by people as it is close to roads and villages.  
170 However, further field investigations in Minjiang River Valley and areas nearby  
171 are necessary to assess the exact distribution and population status of *H.*  
172 *avisoides*. Therefore, we here temporarily assign *H. avisoides* to the category  
173 DD (Data Deficient) according to the International Union for Conservation of  
174 Nature (IUCN Standards and Petitions Committee 2022).

## 175 Discussion

176 The new species *Hemipilia avisoides* has oblong tubers, two erect anthers,  
177 two stigmas that are beneath the rostellum and two sectile pollinia with  
178 viscidium each enclosed within a bursicle. These characteristics fit well into  
179 the category of the *Amitostigma* alliance or *Hemipilia s.l.* (Tang et al. 2015).  
180 *Hemipilia avisoides* has also a solitary, slightly fleshy leaf that is appressed to  
181 substrate, which is quite reminiscent of *Hemipilia s.s.* (Chen et al. 2009).  
182 However, the median rostellum lobe of *H. avisoides* never protrudes between  
183 anther cells like that of *Hemipilia s.s.*

184 Molecular phylogenies did, however, reveal a close relationship between  
185 *Hemipilia s.s.* and *H. avisoides* in a clade (figs. 1–3 in Tang et al. 2015, *H.*  
186 *avisoides* identified as *Ponerorchis cf. limprichtii*). The sister relationship  
187 between *P. limprichtii* ( $\equiv$  *H. occidentichuanensis*) and *H. avisoides* is also  
188 strongly supported in both nuclear and chloroplast trees (Tang et al. 2015),  
189 while they are most similar in morphology (see Taxonomic treatment and  
190 below). Moreover, *H. avisoides* and *P. limprichtii* each occupies a long branch  
191 in molecular trees, exhibiting considerable DNA sequence divergences (Tang  
192 et al. 2015).

193 Amongst the specimens of *P. limprichtii*, one collection by S. Y. Chen et  
194 al. in 1958 caught our attention for it was gathered from Maoxian County at an  
195 elevation of 1780 m, this being close to the localities where we discovered *H.*  
196 *avisoides*. The environment of that region differs from the alpine habitat that  
197 *P. limprichtii* usually favours. After careful examination, we believe that this  
198 specimen represents *H. avisoides* here described, although it was initially  
199 identified as *P. limprichtii*. We highlighted in Fig. 3 the key features, which  
200 facilitated our identification of the specimen. Nevertheless, rather than on  
201 living plants, some subtle features could faintly be observed on pressed  
202 specimens of *H. avisoides* and its similar species. For example, the three-  
203 dimensional structure of flowers would collapse once pressed and the colours  
204 of leaves would fade away when drying. This might obscure the discrepancies  
205 between *H. avisoides* and *P. limprichtii* or even other more distantly related  
206 species like *P. chusua* (D. Don) Soó. We hope that the 3D mesh model  
207 reconstructed in this study (see Data availability) would become helpful for  
208 recognising *H. avisoides* in future research.

209 *Ponerorchis limprichtii* is also distributed in Gansu Province, which is  
210 north of Sichuan Province. According to the vegetation regionalisation of  
211 China (Zhang 2007) and the information of specimens (see Additional  
212 specimens examined), the habitats of *P. limprichtii* in Gansu probably range

213 from arid-valley shrubs to deciduous broadleaved forests at an elevation  
 214 between 1250 and 1850 m. Besides herbarium specimens, there are some  
 215 photo records of *P. limprichtii* in Gansu, despite initially being assigned only to  
 216 genus level or to other species by the photographers, on the web site of Plant  
 217 Photo Bank of China, PPBC (in Chinese; see <http://ppbc.iplant.cn/tu/5920959>  
 218 (by R. B. Zhu in Zhouqu County), <http://ppbc.iplant.cn/tu/5919232> (by R. B.  
 219 Zhu in Wenxian County), <http://ppbc.iplant.cn/tu/5919279> (by R. B. Zhu in  
 220 Wenxian County), <http://ppbc.iplant.cn/tu/7885080> (by X. J. Liu in Chengxian  
 221 County) and the remaining photos in the albums of each plant). The plants  
 222 shown in those photos have a subsquare mid-lobe that is obviously larger  
 223 than the lateral lobes; therefore, we recognised them as *P. limprichtii*.  
 224 Surprisingly, their leaves are green with white, reticulate venation, which  
 225 mainly resemble those of *H. avisoides*. Another online photo of *P. limprichtii*,  
 226 taken by S. L. Kelley in Luhuo County, Sichuan, showed a nearly uniformly  
 227 green leaf  
 228 ([http://hengduan.huh.harvard.edu/fieldnotes/specimens/search/specimen\\_detail.zpt?specimen\\_id=21330&full\\_image=skelley04179](http://hengduan.huh.harvard.edu/fieldnotes/specimens/search/specimen_detail.zpt?specimen_id=21330&full_image=skelley04179)). On the other hand, a  
 229 few individuals of *H. avisoides* were observed in the field to possess  
 230 conspicuously purple spots, along with white veins, on their leaves. We have  
 231 also noticed that the lateral lobes of *P. limprichtii* in Gansu as shown in the  
 232 PPBC photos are often pendulous. Taking these facts into account, the  
 233 abovementioned cases render the diagnostic characteristics of *H. avisoides*  
 234 seemingly cryptic.  
 235

236 According to the spatial delimitation of the Arid valley in the upper  
 237 reaches of Minjiang River (Zheng et al. 2017), of the two *H. avisoides*  
 238 populations we discovered, one is distributed within the range of the Arid  
 239 valley and the other is closely situated next to the Arid valley. The locality of  
 240 the collection by S. Y. Chen et al. in 1958 was not precisely recorded, but the  
 241 elevation of 1780 m implied that the specimen was collected from the range of  
 242 the Arid valley in that region. However, it is notable that, as climate changes,  
 243 the spatial range of the Arid valley varies (Zheng et al. 2017). Focusing on  
 244 vegetation type, based on our field observations, the vegetation where our  
 245 collections of *H. avisoides* occurs could be classified into Form. *Sophora*  
 246 *dauidii* (Franch.) Skeels, Form. *Prunus tangutica* (Batal.) Korsh. and/or Form.  
 247 *Ostryopsis davidiana* Decaisne, which are typical of arid-valley shrubs and  
 248 span an elevation between ca. 1700 and 2500 m (Yang 2007). To sum up, the  
 249 habitats of *H. avisoides* are mostly within the Arid valley in the upper reaches  
 250 of Minjiang River. To our knowledge, other orchids in the same and sympatric  
 251 habitats include *H. physoceras* (Schltr.) Y. Tang & H. Peng, *Habenaria*  
 252 *acianthoides* Schltr. and *Cephalanthera erecta* (Thunb. ex A. Murray) Bl.,  
 253 although each of these species is more widely distributed overall. We believe

254 the ecological characteristics of these orchids, including *Hemipilia avisoides*,  
255 are worthy of future study.

## 256 **Data availability**

257 The 3D mesh model of the uppermost two flowers on an inflorescence and  
258 photos of the corresponding micro-CT-scanned individual of *Hemipilia*  
259 *avisoides*, are available on Zenodo via DOI:  
260 <https://doi.org/10.5281/zenodo.6832154>.

## 261 **Acknowledgements**

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266 Chengdu University of Information Technology for their help in evaluating  
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## 277 **Author contributions**

278 **Xue-Man Wang**: Investigation; Writing – original draft; Writing – review &  
279 editing. **Ying Tang**: Conceptualisation; Investigation; Resources;  
280 Visualisation; Writing – original draft; Writing – review & editing. **Pei-Hao**  
281 **Peng**: Funding acquisition; Supervision. **Hua Peng**: Conceptualisation;  
282 Funding acquisition; Supervision.

## 283 **References**

284 Bateman RM, Hollingsworth PM, Preston J, Luo YB, Pridgeon AM, Chase MW  
285 (2003) Molecular phylogenetics and evolution of Orchidinae and selected  
286 Habenariinae (Orchidaceae). *Botanical Journal of the Linnean Society*  
287 142(1): 1–40. <https://doi.org/10.1046/j.1095-8339.2003.00157.x>

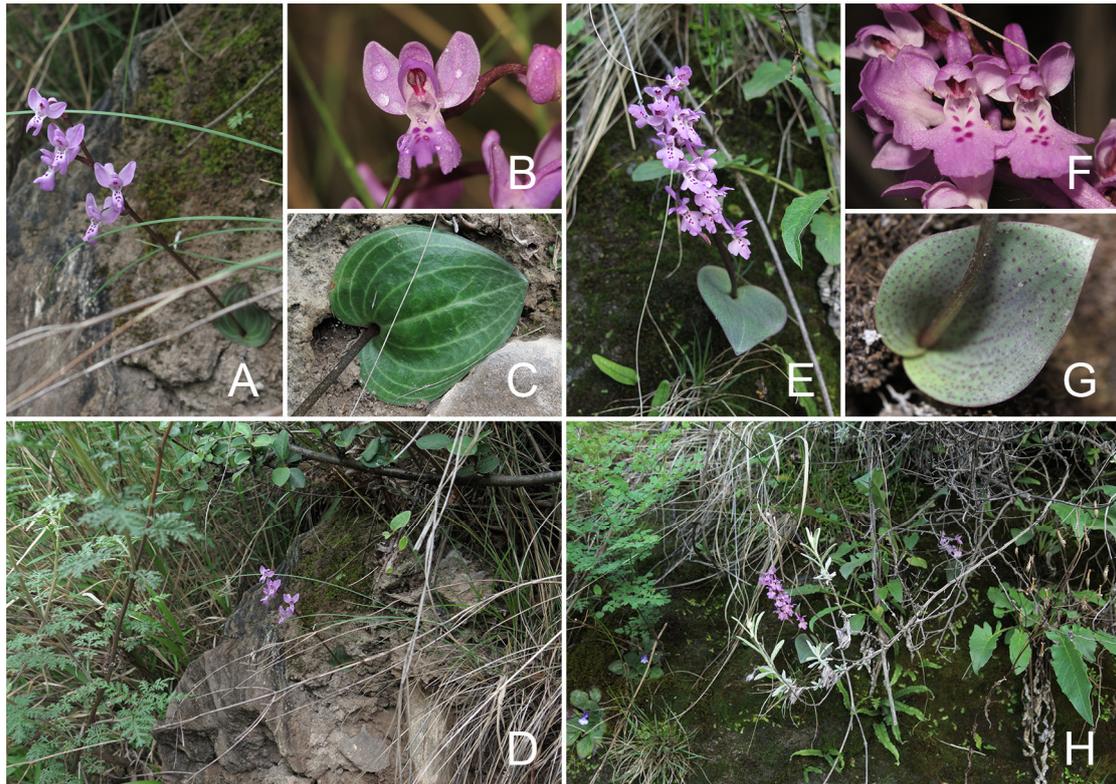
- 288 Chen XQ, Gale SW, Cribb PJ (2009) *Hemipilia* Lindley. In: Wu ZY, Raven PH,  
289 Hong DY (Eds) Flora of China Vol. 25. Science Press, Beijing & Missouri  
290 Botanical Garden Press, St. Louis, 98–100.
- 291 IUCN Standards and Petitions Committee (2022) Guidelines for Using the  
292 IUCN Red List Categories and Criteria. Version 15. Prepared by the  
293 Standards and Petitions Committee.  
294 <https://www.iucnredlist.org/documents/RedListGuidelines.pdf>
- 295 Jin WT, Jin XH, Schuiteman A, Li DZ, Xiang XG, Huang WC, Li JW, Huang  
296 LQ (2014) Molecular systematics of subtribe Orchidinae and Asian taxa  
297 of Habenariinae (Orchideae, Orchidaceae) based on plastid *matK*, *rbcL*  
298 and nuclear ITS. *Molecular Phylogenetics and Evolution* 77: 41–53.  
299 <https://doi.org/10.1016/j.ympev.2014.04.004>
- 300 Jin WT, Schuiteman A, Chase MW, Li JW, Chung SW, Hsu TC, Jin XH (2017)  
301 Phylogenetics of subtribe Orchidinae s.l. (Orchidaceae; Orchidoideae)  
302 based on seven markers (plastid *matK*, *psaB*, *rbcL*, *trnL-F*, *trnH-psba*,  
303 and nuclear nrITS, *Xdh*): implications for generic delimitation. *BMC Plant*  
304 *Biology* 17: 222. <https://doi.org/10.1186/s12870-017-1160-x>
- 305 Luo YB (1999) Studies on the orchid genus *Hemipilia*. PhD Thesis, Institute of  
306 Botany, Chinese Academy of Science, Beijing.
- 307 Luo YB, Chen SC (2000) The floral morphology and ontogeny of some  
308 Chinese representatives of orchid subtribe Orchidinae. *Botanical Journal*  
309 *of the Linnean Society* 134(4): 529–548. [https://doi.org/10.1111/j.1095-](https://doi.org/10.1111/j.1095-8339.2000.tb00549.x)  
310 [8339.2000.tb00549.x](https://doi.org/10.1111/j.1095-8339.2000.tb00549.x)
- 311 Tang Y, Yukawa T, Bateman RM, Jiang H, Peng H (2015) Phylogeny and  
312 classification of the East Asian *Amitostigma* alliance (Orchidaceae:  
313 Orchideae) based on six DNA markers. *BMC Evolutionary Biology* 15: 96.  
314 <https://doi.org/10.1186/s12862-015-0376-3>
- 315 Yang QZ (2007) Study on the arid-valley scrubs in the upper reaches of  
316 Minjiang River. *Journal of Mountain Science* 25(1): 1–32.
- 317 Zhang XS (2007) Vegetation Map of China and Its Geographic Pattern—  
318 Illustration of the *Vegetation Map of The People's Republic of China*  
319 (1:1000000). Geological Publishing House, 625–628.
- 320 Zheng J, Feng WL, Wang FJ, Yuan D, Gong XM, Huang YQ (2017) Spatial

321 definition and its range variation of arid valley in the upper reaches of  
322 Minjiang River. Arid Land Geography 40(3): 541–548.  
323 <https://doi.org/10.13826/j.cnki.cn65-1103/x.2017.03.007>

324 **TABLE 1.** Comparisons in morphology between *Hemipilia avisoides* sp. nov.  
 325 and similar *H. occidensichuanensis*.

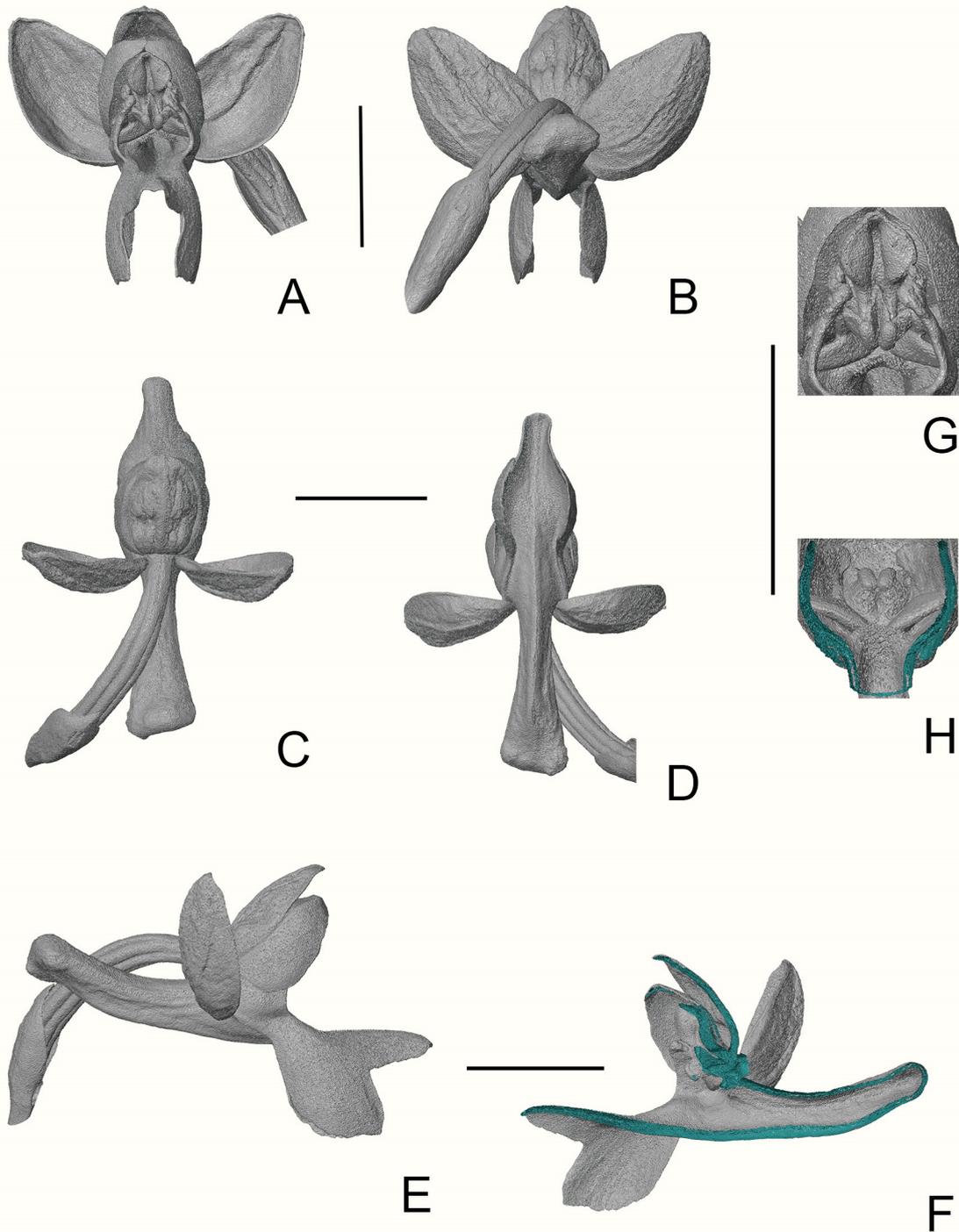
<b>Species</b>	<b><i>Hemipilia avisoides</i></b>	<b><i>H. occidensichuanensis</i></b>
<b>Stem shape</b>	Subterranean, with 1 sheath at base	Partly subterranean, with 1 or 2 (or 3) sheaths at base
<b>Leaf position</b>	Appressed to substrate	Sub-basal
<b>Leaf colour adaxially</b>	Green with white veins, occasionally also with purple spots	Usually green with purple markings, sometimes nearly uniformly green or with white, reticulate venation
<b>Flora bract shape</b>	Elliptic, 5 mm long, always shorter than ovary	Lanceolate or ovate-lanceolate, lower ones nearly as long as ovary, gradually smaller upwards to shorter than ovary
<b>Dorsal sepal shape</b>	Oblong, apex rounded, sometimes concave at each side of central vein below middle	Suboblong, apex subacute
<b>Lateral lip lobe shape</b>	Pendulous, rhombic	Usually horizontal, auricular or transversely suboblong
<b>Middle lip lobe shape</b>	Involute, suboblong in apical view, 2.2 × 1.2 mm, trapeziform when flattened, smaller than lateral lobes, apex rounded or sometimes apiculate	Usually open and flat, subsquare, 4–5 × 3–4 mm, larger than lateral lobes, apex obtuse-rounded, sometimes slightly emarginate or shortly apiculate

326



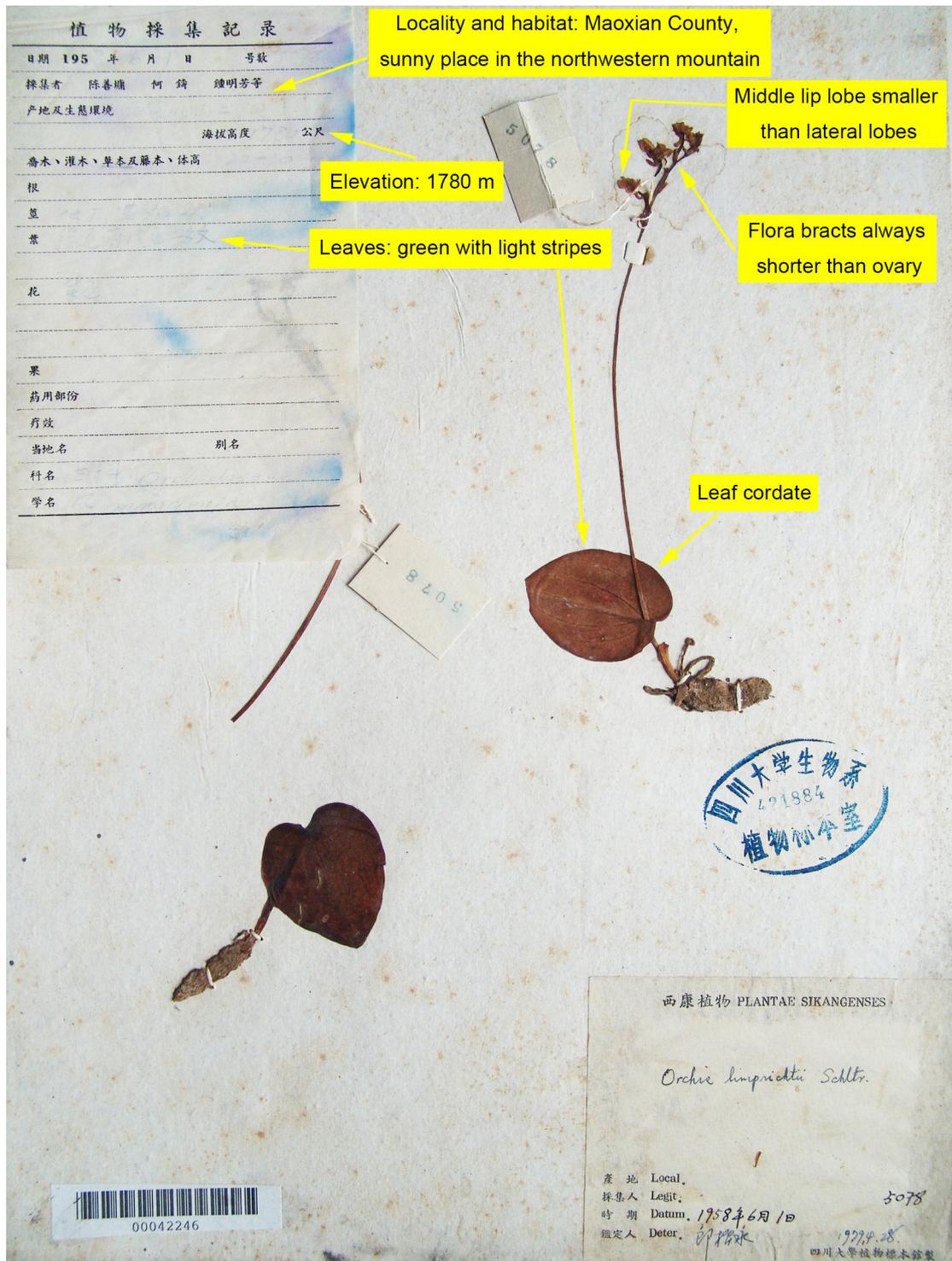
327

328 **Figure 1.** Comparisons between living plants of *Hemipilia avisoides* sp. nov.  
329 and similar *H. occidentichuanensis* in the wild. **A–D**, habit, flowers, leaf and  
330 habitat of *H. avisoides*; **E–H**, habit, flowers, leaf and habitat of *H.*  
331 *occidentichuanensis*. Photographs A–H by Y. Tang.



332

333 **Figure 2.** Different views of *Hemipilia avisoides*, based on 3D mesh model  
334 reconstructed by micro-CT data. **A–E**, front, back, apical, ventral and right-  
335 side views of flower; **F**, left-side view of labellum that is split; **G**, **H**, front and  
336 ventral views of gynostemium. Scale bars, 5 mm.



337

338 **Figure 3.** Specimen of S. Y. Chen, Z. He, M. F. Zhong et al. 5078 (SZ!)  
 339 identified as *Hemipilia avisoides* in this study. Key features, which would  
 340 facilitate the identification of this specimen, are highlighted and arrowed in  
 341 yellow.