Pl. Syst. Evol. 172, 13–34 (1990)

—Plant—
Systematics
and
Evolution

Chemotaxonomic study of the genus *Tabernaemontana* (*Apocynaceae*) based on their indole alkaloid content

J.-P. Zhu, A. Guggisberg, M. Kalt-Hadamowsky, and M. Hesse

Received May 9, 1989

Key words: Angiosperms, *Apocynaceae, Tabernaemontana.* – Indole alkaloids, chemotaxonomy.

Abstract: According to their alkaloidal products species of the "new" genus *Tabernaemontana* can be partly differentiated. This differentiation is in agreement with the "old" genera classification. From the chemotaxonomic point of view a subdivision of subfam. *Plumerioideae* of the *Apocynaceae* is proposed.

The genus *Tabernaemontana* belongs to the family *Apocynaceae* and comprises about 100 species. They occur in tropic as well as subtropic parts of the world. *Tabernaemontana* spp. are famous for their indole alkaloid content. So far, more than 67 species were investigated for indole alkaloids. According to Kisakürek & al. (1983) and Zhu (1988) more than 470 isolations of about 240 structurally different bases were detected. The species investigated so far are listed together with their indole alkaloid content in Table 1 (Beek & al. 1984 d, Zhu 1988). Because of the wide spread occurrence of *Tabernaemontana* and the difficulty in plant collections, the taxonomy of this genus is troublesome (Leeuwenberg 1976). In 1983 a chemotaxonomic investigation of the plant families of *Apocynaceae, Loganiaceae*, and *Rubiaceae* was published by Kisakürek & al. (1983). In this paper many genera were declared as synonyma of the genus *Tabernaemontana*. A complete list of these genera is given in Table 1. The combination of the species was done

Table 1. List of *Tabernaemontana* spp. investigated so far together with synonyma and their indole alkaloid content

T. accedens Muell. (=*Peschiera accedens* Muell. Arg.): (+)-accedine (C4c, α), Achenbach & Schaller (1975); (−)-accedinine (C4c–C5a, α–α); (−)-accedinisine (C4c–C5a, α–α); affinisine (C4c); (−)-N-demethyl-voacamine (C5a–H5a, α–β), Achenbach & Schaller (1976b); (+)-16-epi-N-demethyl-accedine (C4c, α), Achenbach & Schaller (1976a); (−)-16-epi-N(a)-methyl-affinine (C5a, α), Achenbach & Schaller (1975); (−)-voacamidine (C5a–H5a, α–β); (−)-voacamine-N-oxide (C5a–H5a, α–β), Achenbach & Schaller (1976b).

Table 1 (continued)

T. affinis MUELL. ARG. [=*Peschiera affinis* (MUELL. ARG.) MIERS]: (+)-affinine (C 5 a, α), WEISBACH & al. (1963); affinisine (C 4 c); (−)-19-epi-heyneanine (H 5 a, β); heyneanine (H 5 a); coronaridine-pseudoindoxyl (H 6 a), MATOS & al. (1976); vobasine (C 5 a), WEISBACH & al. (1963).

T. africana HOOK. [=*T. chippii* (STAPF) PICHON]: akuammiline (C 4 e); anhydro-vobasine-diol (C 6 c); apparicine (A 4 b); conoduramine (C 5 a − H 5 a); conodurine (C 5 a − H 5 a); conoflorine (P 4 a); conopharyngine (H 5 a); coronaridine (H 5 a); desacetyl-akuammiline (C 4 e); 16-epi-affinine (C 5 a); 16-epi-iso-sitsirikine (C 3 a); 12-hydroxy-akuammicine (S 4 a); 3(R)-hydroxy-conoduramine (C 5 a − H 5 a); 3(S)-hydroxy-conoduramine (C 5 a − H 5 a); 3(R/S)-hydroxy-conodurine (C 5 a − H 5 a); 3(R/S)-hydroxy-decarbomethoxy-conodurine (C 5 a − H 5 a); 3(R)-hydroxy-conopharyngine (H 5 a); 3(S)-hydroxy-conopharyngine (H 5 a); 3(R)-hydroxy-hydroxyindolenine-conopharyngine (H 5 a); 3(S)-hydroxy-hydroxy-indolenine-conopharyngine (H 5 a); hydroxyindolenine-conopharyngine (H 5 a); 3(R)-hydroxy-isovoacangine (H 5 a); 3(S)-hydroxy-isovoacangine (H 5 a); 3(R/S)-hydroxy-voacamine (C 5 a − H 5 a); ibogaline (H 5 a); isositsirikine (C 3 a); isovoacangine (H 5 a), BEEK & al. (1985 c); monogagaine (C 5 a − P 3 a), BEEK & al. (1985 a); normacusine B (C 4 c); 3-oxo-conopharyngine (H 5 a); pericyclivine (C 4 e); picraline (C 5 d); pleiocarpamine (C 4 f); tubotaiwine (A4 a); vobasine (C 5 a); vobasinol (C 5 a), BEEK & al. (1985 c); vobparicine (A 4 b − C 5 a), BEEK & al. (1984 b); vobparicine-N-oxide (A 4 b − 5 a), BEEK & al. (1985 c).

T. albiflora (MIQ.) PULLE: (−)-albifloranine (H 5 a), KAN & al. (1981); (+)-desethyl-ibophyllidine (K 7 a), KAN & al. (1980 a); (+)-20-epi-18-hydroxy-ibophyllidine (K 7 a); (+)-20-epi-19(R)-hydroxy-ibophyllidine (K 7 a); (+)-20-epi-19(S)-hydroxy-ibophyllidine (K 7 a), KAN & al. (1980 b); (+)-20-epi-ibophyllidine (K 7 a), KAN & al. (1980 a); (+)-19-hydroxy-ibophyllidine (K 7 a), KAN & al. (1980 b).

T. amygdalifolia JACQ. (=*T. nereifolia* VAHL): (−)-N-acetyl-12-demethoxy-cylindrocarine (P 5 a); (+)-O-demethyl-palosine (P 5 a); (−)-homocylindrocarpidine (P 5 a, β); (−)-5-oxo-cylindrocarpidine (P 5 a), GANZINGER & HESSE (1976).

T. angulata MART. ex MUELL. ARG. [=*Anacampta angulata* (MART. ex MUELL. ARG.) MIERS]: hydroxyindolenine-voacristine (H 5 a), GARNIER & al. (1984 b).

T. apoda WR. ex SAUV. (=*T. armeniaca* ARECES ex IGLESIAS & DIATTA): apodine (P 6 e), reference no. 412 in KISAKÜREK & al. (1983); desoxo-apodine (P 6 e), IGLESIAS & DIATTA (1975).

T. arborea ROSE ex SMITH: isovoacangine (H 5 a); tabersonine (P 5 a); voacangine (H 5 a), CHAVERRI & CICCIO (1980).

T. attenuata (MIERS) URB.: angustine (V 4); conopharyngine (H 5 a); coronaridine (H 5 a); eglandine (H 6 b); 19-epi-heyneanine (H 5 a); 16-epi-pleiocarpamine (C 4 f); heyneanine (H 5 a); (−)-11-hydroxy-coronaridine (H 5 a); 10-hydroxy-heyneanine (H 5 a); (−)-11-hydroxy-heyneanine (H 5 a); hydroxy-indolenine-coronaridine (H 5 a); ibophyllidine (K 7 a); (−)-iso-voacangine (H 5 a, β); jollyanine (H 5 a); tubotaiwine (A 4 a); voacangine (H 5 a), LADHAR & al. (1981).

T. aurantiaca GAUD. [=*Ervatamia aurantiaca* auct. non; *Rejoua aurantiaca* (GAUD.) GAUD.]: iboluteine (H 6 a); (−)-voaluteine (H 6 a), GUISE & al. (1965); vobtusine (P 6 e − P 6 e), GANZINGER & HESSE (1976).

T. australis MUELL. ARG. [=*Peschiera australis* (MUELL. ARG.) MIERS]: voacamine (C 5 a − H 5 a), GORMAN & al. (1960).

Table 1 (continued)

T. brachyantha STAPF [= *Conopharyngia brachyantha* (STAPF) STAPF]: (−)-anhydrovobasinediol (C 6 c, α); (−)-19-epi-voacorine (C 5 a − H 5 a, α − β); (−)-voacorine (C 5 a − H 5 a, α − β), PATEL & al. (1973).

T. calcarea PICHON [= *Pandaca caducifolia* MGF.; *P. calcarea* (PICHON) MGF.]: (−)-dregamine (C 5 a, α); (+)-20-epi-pandoline (K 5 a, β), ZECHES & al. (1974); (+)-pandine (K 6 a, β), HOIZEY & al. (1974); (+)-pseudotabersonine (K 5 a, β); (+)-20(R)-pseudovincadifformine (K 5 a, β), ZECHES & al. (1975).

T. capuronii LEEUWENBERG (= *Capuronetta elegans* MGF. non *T. elegans* STAPF): (−)-14,15-anhydro-capuronidine (K 5 a, β); (+)-14,15-anhydro-1,2,-dihydro-capuronidine (K 5 a, β), CHARDON-LORIAUX & al. (1978); (+)-capuronidine (K 5 a, β); (+)-capuronine (K 4 a, β), CHARDON-LORIAUX & HUSSON (1975); (−)-capuvosidine (C 5 a − K 5 a, α − β), CHARDON-LORIAUX & al. (1978); (−)-capuvosine (C 5 a − K 4 a, α − β), CHARDON-LORIAUX & HUSSON (1975); (−)-dehydroxy-capuvosine (C 5 a − K 4 a); (−)-N-demethyl-capuvosine (C 5 a − K 4 a), CHARDON-LORIAUX & al. (1978).

T. catharinensis A. DC. [= *Peschiera catharinensis* (A. DC.) MIERS]: (−)-catharinensine (C 4 d, α); (−)-conodurine (C 5 a − H 5 a, α − β); (−)-coronaridine (H 5 a, β); (−)-16-decarbomethoxy-voacamine (C 5 a − H 5 a, α − β); (−)-16-epi-affinine (C 5 a, α); (−)-heyneanine (H 5 a, β); (−)-isovoacangine (H 5 a, β), ARAUJO & al. (1984).

T. cerifera PANCH. & SÉB. [= *Pagiantha cerifera* (PANCH. & SÉB.) MGF.]: apparicine (A 4 b), RAS & al. (1978); (−)-hydroxyindolenine-voacangine (H 5 a, β); (−)-ibogaine (H 5 a, β), HARMOUCHE & al. (1976); (−)-pagicerine (C 6 i), BERT & al. (1985).

T. ciliata PICHON: pandicine (P 5 a − C 5 e), KAN-FAN & al. (1981).

T. citrifolia L., [= *T. oppositifolia* (SPRENG.) URB.]: akuammidine (C 4 c); (−)-apparicine (A 4 b); (−)-coronaridine (H 5 a, β), KUTNEY & PEREZ (1982); (−)-14,15-dehydro-tetrastachyne (H 5 a − P 5 a), ABAUL & al. (1984); (−)-hydroxyindolenine-voacangine (H 5 a, β); (−)-ibogamine (H 5 a, β); (−)-iboxygaine (H 5 a, β); (−)-lochnericine (P 5 a); (−)-19-oxo-voacangine (H 5 a); (−)-19-oxo-voacristine (H 5 a); (−)-tabersonine (P 5 a); (+)-vallesamine (A 4 b), KUTNEY & PEREZ (1982); voacamine (C 5 a − H 5 a), GORMAN & al. (1960); (−)-voacangine (H 5 a, β); (−)-voacristine (H 5 a, β), KUTNEY & PEREZ (1982).

T. coffeoides BOJ. ex A. DC. [= *T. coffeaefolia* BOJ.; *T. modesta* BAK.; *T. membranacea* A. DC.; *Hazunta angustifolia* PICHON; *H. coffeoides* (BOJ. ex A. DC.) PICHON; *H. costata* MGF.; *H. membranacea* forma *pilifera* (A. DC.) PICHON; *H. modesta* (BAK.) PICHON; *H. modesta* (BAK.) PICHON var. *methuenii* (STAPF & GREEN) PICHON subvar. *methuenii* MGF.; *H. modesta* (BAK.) PICHON var. *methuenii* (STAPF & GREEN) PICHON subvar. *velutina* (PICHON) MGF.; *H. modesta* var. *modesta* subvar. *brevituba* MGF.; *H. modesta* var. *modesta* subvar. *divaricata* MGF.; *H. modesta* (BAK.) PICHON var. *modesta* subvar. *modesta*; *H. modesta* var. *modesta* subvar. *montana* MGF.; *H. silicola* PICHON; *H. velutina* PICHON]: apparicine (A 4 b); 1,2-dihydro-ellipticine (A 4 d), BUI & al. (1980); (−)-20′(S)-19′20′-dihydro-tabernamine (C 5 a − H 5 a); 19(R)-19-hydroxy-tabernaelegantine A (C 5 a − H 5 a), URREA & al. (1981); 14,15-dihydroxy-vincadifformine (P 5 a), BUI & al. (1980); dimethoxy-tetraphyllicine (C 5 c); (−)-dregamine (C 5 a, α), BUI & al. (1977); (−)-19-epiheyneanine (H 5 a, β), VECCHIETTI & al. (1978); 16-epi-6-oxo-silicine (C 7 b), BUI & al. (1980); (−)-hazuntine (P 5 a); (−)-hazuntinine (P 5 a), GANZINGER & HESSE (1976); ibogamine (H 5 a), BUI & al. (1980); isovoacangine (H 5 a), BUI & al. (1977); lochnericine (P 5 a), BUI & al. (1980); methoxy-tetraphyllicine (C 5 c), BUI & al. (1977); methuenine (C 7 b); (−)-modestanine (P 6 e); 6-oxo-silicine (C 7 b); 3-oxo-tabersonine (P 5 a); pericyclivine (C 4 e); silicine (C 7 b), BUI & al. (1980); (−)-tabernaelegantine A (C 5 a − H 5 a), VECCHIETTI & al. (1978);

Table 1 (continued)

tabernaemontanine (C 5 a); tabersonine (P 5 a), BUI & al. (1980); tetraphyllicine (C 5 c); trimethoxy-tetraphyllicine (C 5 c), BUI & al. (1977); vallesamine (A 4 b), BUI & al. (1980); (+)-voacarpine (C 4 c, α), POTIER & al. (1968); vobasine (C 5 a), BUI & al. (1980).

T. contorta STAPF [= *Conopharyngia contorta* (STAPF) STAPF]: conopharyngine (H 5 a); (−)-ibogaine (H 5 a, β); voacristine (H 5 a), PATEL & al. (1967).

T. crassa BENTH. (*T. durissima* STAPF; *T. jollyana* PIERRE ex STAPF; *T. thonneri* TH. DUR. & DE WILD. ex STAPF; *Conopharyngia crassa* (BENTH.) STAPF; *C. durissima* (STAPF) STAPF; *C. gentilii* DE WILD; *C. jollyana* STAPF; *C. odoratissima* STAPF; *C. thonneri* (TH. DUR. & DE WILD ex STAPF) STAPF; *Gabunia dorotheae* WERH.; *G. gentilii* DE WILD.; *G. odoratissima* STAPF]: O-acetyl-polyneuridine (C 4 c), HOOTELE & al. (1967); (−)-anhydrovobasinediol (C 6 c, α), DUGAN & al. (1969 b); (−)-conoduramine (C 5 a − H 5 a, α − β); (−)-conodurine (C 5 a − H 5 a, α − β), RENNER & FRITZ (1964); (−)-conopharyngine (H 5 a, β); (+)-crassanine (H 6 c), CAVA & al. (1968 b); heyneanine (H 5 a); (−)-19-hydroxy-conopharyngine (H 5 a); 3-hydroxy-coronaridine (H 5 a), HOOTELE & al. (1967); (−)-hydroxyindolenine-cornaridine (H 5 a, β), DAS & al. (1967); 19-hydroxy-3-oxocoronaridine (H 5 a), HOOTELE & PECHER (1968); (−)-jollyanine (H 5 a), HOOTELE & al. (1967); (−)-3-oxoconopharyngine (H 5 a); 3-oxo-coronaridine (H 5 a), HOOTELE & PECHER (1968); tabersonine (P 5 a), GANZINGER & HESSE (1976); voacristine (H 5 a), HOOTELE & al. (1967).

T. crassifolia PICHON [= *Pandaca crassifolia* (PICHON) MGF.]: (+)-pandine (K 6 a, β); (+)-pseudotabersonine (K 5 a, β); (+)-pseudovincadifformine (K 5 a, β), GANZINGER & HESSE (1976).

T. cumminsii auct. non (= *T. pachysiphon* STAPF): decarbomethoxy-tetrahydro-secodine (P 3 a), GANZINGER & HESSE (1976).

T. cymosa JACQ.: angustine (V 4); coronaridine (H 5 a); decarbomethoxy-voacamine (C 5 a − H 5 a), GHORBEL & al. (1981); (−)-14,15-dehydro-tetrastachyne (H 5 a − P 5 a), ABAUL & al. (1984); N-demethyl-voacamine (C 5 a − H 5 a, α − β); 16-epi-iso-sitsirikine (C 3 a); 19-epi-voacristine (H 5 a); 10-hydroxy-coronaridine (H 5 a); 10-hydroxy-heyneanine (H 5 a); hydroxyindolenine-ibogaine (H 5 a); hydroxyindolenine-voacangine (H 5 a); ibogaine (H 5 a); 10-methoxy-eglandine (H 6 b); olivacine (A 4 d); 3-oxo-voacangine (H 5 a); (+)-pleiocarpamine (C 4 f, α); pseudoindoxyl-voacangine (H 6 a); tubotaiwine (A 4 a); voacamidine (C 5 a − H 5 a); voacamine (C 5 a − H 5 a); voacangine (H 5 a); voacristine (H 5 a); vobasine (C 5 a), GHORBEL & al. (1981).

T. debrayi (MGF.) LEEUWENBERG (= *Pandaca debrayi* MGF.): apparicine (A 4 b); (−)-dregamine (C 5 a, α); (+)-pandine (K 6 a, β), HOIZEY & al. (1974).

T. dichotoma ROXB. ex WALL. [= *Ervatamia dichotoma* (ROXB. ex WALL.) BURKILL; *Pagiantha dichotoma* (ROXB. ex WALL.) MGF.]: (−)-apparicine (A 4 b), PERERA & al. (1983 a); O-acetyl-vallesamine (A 4 b); conoflorine (P 4 a); coronaridine (H 5 a), PERERA & al. (1984 b); N(4)-demethyl-tabernamine (C 5 a − H 5 a), PERERA & al. (1985); dichomine (K 5 b, α), PERERA & al. (1983 a); (+)-16,22-dihydro-16-hydroxy-apparicine (A 4 b), PERERA & al. (1984 a); 19-epi-heyneanine (H 5 a), PERERA & al. (1984 b); 19-epi-iboxygaine (H 5 a), PERERA & al. (1983 a); 19-epi-3-ketopropyl-heyneanine (H 5 a), PERERA & al. (1985); 19-epi-voacristine (H 5 a), PERERA & al. (1983 a); (−)-heyneanine (H 5 a, β), SCHNOES & al. (1968); 3′(R/S)-hydroxy-N(4)-demethyl-ervahanine A (C 5 a − H 5 a); 3′(R/S)-hydroxy-N(4)-demethyl-ervahanine B (C 5 a − H 5 a); 3′(R/S)-hydroxy-N(4)-demethyl-tabernamine (C 5 a − H 5 a), PERERA & al. (1985); hydroxyindolenine-conoflorine (P 4 a), PERERA & al. (1984 a); (−)-hydroxyindolenine-voacristine (H 5 a, β), SCHNOES & al. (1968); 3′(R/S)-hydroxy-tabernamine (C 5 a − H 5 a); 3′(R/S)-hydroxy-voacamine (C 5 a − H 5 a); ibogamine (H 5 a), PERERA & al. (1985); iso-methuenine (C 7 b), PERERA & al. (1983 a); (−)-3-keto-

Table 1 (continued)

propyl-coronaridine (H 5 a), PERERA & al. (1984 b); 12-methoxy-conoflorine (P 4 a), PERERA & al. (1983 a, 1984 a); monogagaine (C 5 a – P 3 a), BEEK & al. (1985 a); 19(R)-3-oxido-coronaridine (H 6 d); 3-oxo-coronaridine (H 5 a), PERERA & al. (1985); perivine (C 5 a), PERERA & al. (1983 a); stemmadenine (A 3), PERERA & al. (1983 b); tabernamine (C 5 a – H 5 a), PERERA & al. (1985); (–)-tabersonine (P 5 a), PERERA & al. (1983 b); vallesamine (A 4 b), PERERA & al. (1984 b); voacamine (C 5 a – H 5 a), PERERA & al. (1985); voacangine (H 5 a), PERERA & al. (1983 b); vobasine (C 5 a), PERERA & al. (1983 a).

T. divaricata (L.) R. BR. ex ROEM. & SCHULT. [= *T. alternifolia* L.; *T. coronaria* (JACQ.) WILLD.; *Ervatamia coronaria* (JACQ.) STAPF; *E. divaricata* (L.) BURKILL]: (+)-conoflorine (P 4 a, α), RAJ & al. (1974); coronaridine (H 5 a), RASTOGI & al. (1980); dregamine (C 5 a), TALAPATRA & al. (1975); (+)-ervatinine (P 4 a), ATTA-UR-RAHMAN & al. (1985); (±)-heyneanine (H 5 a, a + β), RASTOGI & al. (1980); hyderabadine (P 5 c), ATTA-UR-RAHMAN & DAULATABADI (1983); (±)-19-hydroxy-coronaridine (H 5 a, α + β); hydroxyindolenine-coronaridine (H 5 a); (–)-5-hydroxy-6-oxo-coronaridine (H 5 a); ibogamine (H 5 a), RASTOGI & al. (1980); (+)-lahoricine (C 5 v), ATTA-UR-RAHMAN & al. (1984); (+)-mehranine (P 5 a), ATTA-UR-RAHMAN & al. (1983); (–)-3-oxo-coronaridine (H 5 a, β); (–)-5-oxo-coronaridine (H 5 a); (–)-6-oxo-coronaridine (H 5 a), RASTOGI & al. (1980); pseudo-vobparicine (A 4 b – C 5 a), BEEK & al. (1985 b); voacamine (C 5 a – H 5 a), RASTOGI & al. (1980); voacristine (H 5 a), TALAPATRA & al. (1975).

T. eglandulosa STAPF [= *T. brachypoda* SCHUM.; *T. chartacea* PICHON; *T. crispiflora* SCHUM.; *T. latifolia* (STAPF) PICHON; *Gabunia brachypoda* (SCHUM.) STAPF; *G. crispiflora* (SCHUM.) STAPF; *G. eglandulosa* (STAPF) STAPF; *G. latifolia* STAPF; *G. longiflora* STAPF; *G. macrocarpa* BOITEAU]: 16,17-anhydro-tacamine (T 5 a, β); conoflorine (P 4 a), BEEK & al. (1984 c); conopharyngine (H 5 a), PATEL & al. (1967); coronaridine (H 5 a); decarbomethoxy-tacamine (T 5 a, β); (+)-20(R)-1,2-dehydro-pseudo-aspidospermidine (K 5 a, β); ()-1,2-dehydro-20(S)-hydroxy-pseudo-apidospermidine (K 5 a, β), BEEK & al. (1984 c); dichomine (K 5 b, α), PERERA & al. (1983 a); (+)-20(R)-15,20-dihydro-cleavamine (K 4 a, β); (–)-20(S)-15,20-dihydro-cleavamine (K 4, β), BEEK & al. (1984 c); (–)-eglandine (H 6 b, β); (–)-eglandulosine (H 5 a, β), LE MEN & al. (1974); 16-epi-decarbomethoxy-tacamine (T 5 a, β); 16-epi-tacamine (T 5 a, β), BEEK & al. (1984 c); 3-hydroxy-coronaridine (H 5 a), AGWADA & al. (1975); 11-hydroxy-coronaridine (H 5 a), BEEK & al. (1984 c); (–)-3-hydroxy-isovoacangine (H 5 a, β), AGWADA & al. (1975); 19(S)-hydroxy-tacamine (T 5 a, β); 17-hydroxy-tacamonine (T 5 a, β); ibogamine (H 5 a); norfluorcurarine (S 4); 20(R)-pseudo-vincadifformine (K 5 a); 20(S)-pseudo-vincadifformine (K 5 a), BEEK & al. (1984 c); tacamine (T 5 a, β), BEEK & al. (1982); tacamonine (T 5 a, β); tubotaiwine (A 4 a); (A 4 a); 20(R),14(S)-velbanamine (K 4 a), BEEK & al. (1984 c); voacamine (C 5 a – H 5 a); vobasine (C 5 a), AGWADA & al. (1975).

T. elegans STAPF [= *Conopharyngia elegans* (STAPF) STAPF]: (–)-conoduramine (C 5 a – H 5 a, α – β); (–)-taberna-elegantine A (C 5 a – H 5 a); (+)-tabernaelegantine B (C 5 a – H 5 a); (–)-tabernaelegantine C (C 5 a – H 5 a); (+)-tabernaelegantine D (C 5 a – H 5 a), BOMBARDELLI & al. (1976).

T. eusepala A. DC. [= *Pandaca eusepala* (A. DC.) MGF.]: (+)-20(S)-1,2-dehydro-pseudo-aspidospermidine (K 5 a, β); (+)-20(R)-15,20-dihydro-cleavamine (K 4 a, β); (–)-19-epi-voacristine (H 5 a, β); (+)-hydroxyindolenine-ibogaine (H 5 a, β); (–)-ibogaine (H 5 a, β); (–)-20(S)-15,20-pseudo-cleavamine (K 4 a, β), QUIRIN & al. (1975).

T. glandulosa (STAPF) PICHON (= *Gabunia glandulosa* STAPF): (–)-12-demethoxy-tabernulosine (C 5 d), ACHENBACH & al. (1982); (–)-19-ethoxy-coronaridine (H 5 a), ACHENBACH & RAFFELSBERGER (1980 a); (–)-19-hydroxy-coronaridine (H 5 a); 19-hydroxy-ibogamine (H 5 a), ACHENBACH & al. (1980); (–)-tabernulosine (C 5 d), ACHENBACH & al. (1982).

Table 1 (continued)

T. hainanensis (TSIANG) LEEUWENBERG: coronaridine (H 5a), FENG & al. (1982); (−)-ervahanine A (C 5a−H 5a); (−)-ervahanine B (C 5a−H 5a); (−)-ervahanine C (C 5a−H 5a), FENG & al. (1981); geissoschizol (C 3a); heyneanine (H 5a); (−)-3-(β-hydroxyethyl)-coronaridine (H 5a); 10-hydroxy-geissoschizol (C 3a); (−)-10-hydroxy-heyneanine (H 5a); hydroxyindolenine-coronaridine (H 5a); ibogamine (H 5a); 3-oxo-coronaridine (H 5a); perivine (C 5a); vobasine (C 5a), FENG & al. (1982).

T. heterophylla VAHL [= *Stenosolen heterophyllus* (VAHL) MGF.]: affinisine (C 4c); (−)-apparicine (A 4b), KAN & al. (1984); conoflorine (P 4a), HENRIQUES & al. (1980); coronaridine (H 5a); 16-decarbomethoxy-voacamine (C 5a−H 5a); KAN & al. (1984); (+)-3-epi-ervafolidine (K 7c−P 5a); (+)-3-epi-19′-hydroxy-ervafolidine (K 7c−P 5a), HENRIQUES & al. (1982); (+)-ervafolene (K 7c−P 5a), HENRIQUES & al. (1980); (+)-ervafolidine (K 7c−P 5a, β−α), HENRIQUES & al. (1982); (+)-ervafoline (K 7c−P 5a, β−α), HENRIQUES & al. (1979); (+)-19′-hydroxy-ervafolene (K 7c−P 5a), HENRIQUES & al. (1980); (+)-19′(R)-hydroxy-ervafolidine (K 7c−P 5a), HENRIQUES & al. (1982); (+)-19′-hydroxy-ervafoline (K 7c−P 5a), HENRIQUES & al. (1980); hydroxyindolenine-voacangine (H 5a); ibogamine (H 5a); ibogaine (H 5a); isotabernamine (C 5a−H 5a); olivacine (A 4d); pandine (K 6a); pandoline (K 5a); (−)-tabernamine (C 5a−H 5a, α−β); 3,4,14,19-tetrahydro-olivacine (A 4d); vallesamine (A 4b); voacamine (C 5a−H 5a); voacangine (H 5a); vobasine (C 5a), KAN & al. (1984).

T. heyneana WALL. [*Ervatamia heyneana* (WALL.) COOKE; *Pagiantha heyneana* (WALL.) MGF.]: (+)-O-acetyl-vallesamine (A 4b); (−)-apparicine (A 4b); camptothecine; (−)-coronaridine (H 5a, β); dihydro-condylocarpine (A4a), GUNASEKERA & al. (1980); (−)-heyneanine (H 5a, β); GOVINDACHARI & al. (1965); 19(S)-heyneanine (H 5a); (−)-heyneatine (H 6d); 10-hydroxy-coronaridine (H 5a); (+)-hyroxyindolenine-voacangine (H 5a, α), GUNASEKERA & al. (1980); ()-iso-voacristine (H 5a, β), RAO & SINGRI (1979); (+)-10-methoxy-eglandine-N-oxide (H 6b); 9-methoxy-camptothecine, GUNSASEKERA & al. (1980); 3-oxo-coronaridine (H 5a), MEYER & al. (1973); voacangine (H 5a), GUNASEKERA & al. (1980); voacangine-pseudoindoxyl (H 6a), MEYER & al. (1973); (−)-voacristine (H 5a, β); voacryptine (H 5a), GUNASEKERA & al. (1980).

T. holstii SCHUM. [= *T. pachysiphon* STAPF; *Conopharyngia holstii* (SCHUM.) STAPF]: conodurine (C 5a−H 5a); 3-oxo-conodurine (C 5a−H 5a); 3-oxo-coronaridine (H 5a); gabunine (C 5a−H 5a), KINGSTON & al. (1977).

T. humblotii (BAILL.) PICHON [= *T. ochrascens* PICHON; *Pandaca ochrascens* (PICHON) MGF.; *P. speciosa* MGF.]: apparicine (A 4b), PANAS & al. (1974); (−)-16-decarbomethoxy-voacamine (C 5a−H 5a, α−β), LÉVY & al. (1975); (−)-19-epi-iboxygaine (H 5a, β); (−)-19-epi-iboxygaline (H 5a, β), PANAS & al. (1974); (−)-ibogaine (H 5a, β), LÉVY & al. (1975); (−)-ibogaline (H 5a, β), PANAS & al. (1974); iboluteine (H 6a); (−)-iboxygaine (H 5a, β); (−)-voacangine (H 5a, β); (−)-voacristine (H 5a, β), LÉVY & al. (1975).

T. inconspicua STAPF: apparicine (A 4b); 3,14-dihydro-ellipticine (A 4d); 16-epi-isositsirikine (C 3a); (−)-16-epi-methuenine (C 7b); 16-epi-methuenine N-oxide (C 7b); 10-hydroxy-coronaridine (H 5a); 10-hydroxy-heyneanine (H 5a), MORFAUX & al. (1982); methuenine (C 7b); methuenine-N-oxide (C 7b), BAKANA & al. (1984); 3,6-oxido-voacangine (H 6b), MORFAUX & al. (1982); 6-oxo-methuenine (C 7b), BAKANA & al. (1984); tetrahydro-ellipticine (A 4d); tubotaiwine (A 4a); voacangine (H 5a); (−)-voacangine-3-carbonitrile (H 5a); voacristine (H 5a); vobasine (C 5a), MORFAUX & al. (1982).

T. johnstonii (STAPF) PICHON (= *T. stapfiana* BRITTEN; *Conopharyngia johnstonii* STAPF): conoduramine (C 5a−H 5a); conodurine (C 5a−H 5a); 19,20-epoxy-conoduramine (C 5a−H 5a), KINGSTON & al. (1978); gabunamine (C 5a−H 5a), CORDELL & SAXON

Table 1 (continued)

(1981); gabunine (C 5 a – H 5 a); ibogamine (H 5 a); iso-voacangine (H 5 a); (–)-tabernamine (C 5 a – H 5 a, α – β), KINGSTON & al. (1978).

T. laeta MART. [= *Peschiera laeta* (MART.) MIERS]: (–)-affinine (C 5 a, α); (+)-akuammidine (C 4 c, α); (–)-conodurine (C 5 a – H 5 a, α – β), VOTICKY & al. (1977).

T. laurifolia BLANCO non L. (= *T. pandacaqui* POIR.): ibogamine (H 5 a); iboxygaine (H 5 a); iso-voacangine (H 5 a), CAVA & al. (1965 a); (–)-iso-voacristine (H 5 a, β), YULDASHEV & al. (1965); tabernanthine (H 5 a), CAVA & al. (1965 a).

T. longiflora BENTH. [= *Conopharyngia longiflora* (BENTH.) STAPF]: (+)-conoflorine (P 4 a, α), GANZINGER & HESSE (1976); conopharyngine (H 4 a), DUGAN & al. (1969 a); 16-decarbomethoxy-voacamine (C 5 a – H 5 a); voacamine (C 5 a – H 5 a); voacorine (C 5 a – H 5 a); voacristine (H 5 a), HESSE (1968).

T. lundii A. DC. [= *Peschiera lundii* (A. DC.) MIERS]: coronaridine (H 5 a); (–)-19-epi-voacristine (H 5 a, β); ibogaine (H 5 a); iboxygaine (H 5 a); (+)-hydroxyindolenine-iboxygaine (H 5 a, β); (–)-voacristine (H 5 a, β); (–)-voacristine-pseudoindoxyl (H 6 a, β); vobasine (C 5 a), HWANG & al. (1969).

T. macrocalyx MUELL. ARG. [= *Anacampta macrocalyx* (MUELL. ARG.) MGF.]: coronaridine (H 5 a), BRUNETON & al. (1979); 19-epi-voacristine (H 5 a); heyneanine (H 5 a); hydroxyindolenine-coronaridine (H 5 a); hydroxyindolenine-voacangine (H 5 a); hyroxyindolenine-voacristine (H 5 a); 3-oxo-hydroxyindolenine-coronaridine (H 5 a), GARNIER & al. (1984 a); tabersonine (P 5 a), BRUNETON & al. (1979); voacangine (H 5 a); voacristine (H 5 a), GARNIER & al. (1984 a).

T. macrocarpa JACK [= *Ervatamia macrocarpa* (JACK) MERR.; *Pagiantha macrocarpa* (JACK) MGF.]: (+)-conoflorine (P 4 a), α); coronaridine (H 5 a); hydroxyindolenine-voacangine (H 5 a); (–)-voacangine (H 5 a, β), MIET & POISSON (1977).

T. mauritiana POIR. [= *T. callosa* PICHON; *T. telfairiana* WALL.; *Pandaca mauritiana* (POIR.) MGF. & BOITEAU]: dregamine (C 5 a); vobasine (C 5 a), HOIZEY & al. (1974).

T. minutiflora PICHON [= *Pandaca minutiflora* (PICHON) MGF.]: (+)-tubotaiwine (A 4 a, α), PETITFRERE & al. (1975).

T. mocquerysii A. DC. [= *Pandaca boiteaui* MGF. excl. paratype BOITEAU 2121 = *T. callosa*; *P. mocquerysii* (A. DC.) MGF.]: capuvosidine (C 5 a – K 5 a); (–)-20(S)-capuvosidine (C 5 a – K 5 a), ANDRIANTSIFERANA & al. (1979); (–)-coronaridine (H 5 a, β), BELLEFON & al. (1975); 16-decarbomethoxy-voacamine (C 5 a – H5 a); (+)-19,20-dehydro-ervatamine (C 7 b, α); (+)-20(S)-1,2-dehydro-pseudoaspidospermidine (K 5 a, β); (–)-dehydroxy-capuvosidine (C 5 a – K 4 a); (–)-dehydroxy-isocapuvosine (C 5 a – K 4 a); 20(S)-dihydro-capuvosidine (C 5 a – K 5 a); (+)-20(R)-15,20-dihydro-cleavamine (K 4 a, β); (–)-20(S)-15,20-dihydro-cleavamine (K 4 a, β); (–)-20(S)-1,2-dihydro-pseudoaspidospermine (K 5 a), (+)-20(R)-1,2-dihydropseudoaspidospermine (K 5 a), ANDRIANTSIFERANA & al. (1979); (–)-ervitsine (C 8 b), ANDRIANTSIFERANA & al. (1977); (–)-19-epi-heyneanine (H 5 a, β); (–)-19-epi-voacristine (H 5 a, β), BELLEFON & al. (1975); methuenine (C 7 b); tubotaiwine (A 4 a); voacamine (C 5 a – H 5 a), ANDRIANTSIFERANA & al. (1979); (–)-voacangine (H 5 a, β); (–)-voacristine (H 5 a, β), BELLEFON & al. (1975).

T. mucronata MERR. [= *Ervatamia mucronata* (MERR.) MGF.]: coronaridine (H 5 a), reference no. 197 in KISAKÜREK & al. (1983); (–)-heyneanine (H 5 a, β), BELLEFON & al. (1975); tabernaemontanine (C 5 a), reference no. 197 in KISAKÜREK & al. (1983).

T. odoratissima (STAPF) LEEUWENBERG (= *Gabunia odoratissima* STAPF; *T. crassa* BENTH.): (–)-conoduramine (C 5 a – H 5 a, α – β); (–)-conodurine (C 5 a – H 5 a, α – β); (–)-coronaridine (H 5 a, β); (–)-gabunine (C 5 a – H 5 a, α – β), CAVA & al. (1965 b).

Table 1 (continued)

T. olivacea MUELL. ARG.: (+)-akuammidine (C 4 c); (+)-condylocarpine-N-oxide (A 4 a, α); coronaridine (H 5 a); coronaridine-pseudoindoxyl (H 6 a); heyneanine (H 5 a); (−)-hydroxyindolenine-coronaridine (H 5 a, β); (−)-hydroxy-indolenine-voacangine (H 5 a, β); ibogaine (H 5 a), ibogamine (H 5 a); voacangine (H 5 a); (−)-voacangine-pseudoindoxyl (H 6 a); (6−)-voacristine (H 5 a, β), ACHENBACH & RAFFELSBERGER (1980 b).

T. orientalis R. BR. [= *T. floribunda* BL.; *T. pubescens* R. BR.; *Ervatamia daemeliana* DOMIN.; *E. floribunda* (BL.) PICHON; *E. lifuana* BOITEAU; *E. montensis* MOORE; *E. obtusiuscula* MGF.; *E. orientalis* (R. BR.) DOMIN; *E. pubescens* (R. BR.) DOMIN]: apparicine (A 4 b); (+)-16-decarbomethoxy-20′-dihydro-voacamine (C 5 a−H 5 a, α−β); (+)-16-decarbomethoxy-20′-epi-20′-dihydro-voacamine (C 5 a−H 5 a, α−β); 16-decarbomethoxy-voacamine (C 5 a−H 5 a); (+)-19,20-dehydro-ervatamine (C 7 b, α); (−)-dregamine (C 5 a, α); (−)-20-epi-ervatamine (C 7 b, α), KNOX & SLOBBE (1975); (+)-20-epi-pandoline (K 5 a, β), BRUNETON & al. (1976); (−)-ervatamine (C 7 b, α); (−)-ibogaine (H 5 a, β); (−)-iboxygaine (H 5 a, β); voacamine (C 5 a−H 5 a), KNOX & SLOBBE (1975); (−)-voacristine (H 5 a, β), ACHENBACH & RAFFELSBERGER (1980 b); vobasine (C 5 a), KNOX & SLOBBE (1975).

T. pachysiphon STAPF [= *T. angolensis* STAPF; *T. cumminsii* auct. non; *T. holstii* SCHUM.; *T. pachysiphon* var. *cumminsii* (STAPF) HUBER; *Conopharyngia angolensis* (STAPF) STAPF; *C. cumminsii* STAPF; *C. holstii* (SCHUM.) STAPF; *C. pachysiphon* (STAPF) STAPF]: (−)-affinine (C 5 a, α); anhydro-vobasindiol (C 6 c); apparicine (A 4 b); conoduramine (C 5 a−H 5 a); conodurine (C 5 a−H 5 a); (−)-conopharyngine (H 5 a, β), BEEK & al. (1984 a); conopharyngine-pseudoindoxyl (H 6 a), reference no. 164 in KISAKÜREK & al. (1983); coronaridine (H 5 a), PATEL & al. (1967); decarbomethoxy-15,20;16,17-tetrahydro-secodine (P 3); 11-demethyl-conoduramine (C 5 a−H 5 a); 16-epi-affinine (C 5 a); 16-epi-iso-sitsirikine (C 3 a); gabunine (C 5 a); 3(R)-hydroxy-conopharyngine (H 5 a); 3(S)-hydroxy-conopharyngine (H 5 a); 19(S)-hydroxy-conopharyngine (H 5 a); hydroxyindolenine-conopharyngine (H 5 a); ibogaline (H 5 a); iso-sitsirikine (C 3 a); iso-voacangine (H 5 a); jollyanine (H 5 a); lochnericine (P 5 a); normacusine B (C 4 c); 3-oxo-conodurine (C 5 a−H 5 a); 3-oxo-coronaridine (H 5 a); pericyclivine (C 4 e); perivine (C 5 a); tubotaiwine (A 4 a); tubotaiwine N-oxide (A 4 a); voacamine (C 5 a−H 5 a), BEEK & al. (1984 a); (−)-voacangine (H 5 a, β), PATEL & al. (1967); vobasine (C 5 a), BEEK & al. (1984 a).

T. pandacaqui POIR. [= *T. laurifolia* BLANCO non L.; *T. semperflorens* PERR.; *Ervatamia pandacaqui* (POIR.) PICHON]: (−)-coronaridine (H 5 a, β), AGUILAR-SANTOS & al. (1964); deformo-akuammidine (C 4 c); (+)-20-epi-lochneridine (S 4 a, β); (+)-ervafolidine (K 7 c−P 5 a, β−α); (+)-ervafoline (K 7 c−P 5 a, β−α); (+)-iso-ervafolidine (K 7 c−P 5 a, β−α), LATHULIÈRE & al. (1970).

T. penduliflora SCHUM. [= *Conopharyngia penduliflora* (SCHUM.) STAPF]: (−)-conopharyngine (H 5 a, β); coronaridine (H 5 a), PATEL & al. (1967).

T. psychotriifolia H. B. K. [= *Peschiera psychotriifolia* (H. B. K.) MIERS]: (−)-affinine (C 5 a, β); (−)-anhydrovobasinediol (C 6 c, α), BURNELL & MEDINA (1971); coronaridine (H 5 a), GORMAN & al. (1960); 16-epi-vobasinic acid (C 5 a), BURNELL & MEDINA (1971); voacamine (C 5 a−H 5 a); voacangine (H 5 a), GORMAN & al. (1960).

T. retusa (LAM.) PICHON [= *T. noronhiana* BOJ. ex A. DC.; *Conopharyngia retusa* (LAM.) DON; *Pandaca retusa* (LAM.) MGF.; *Plumeria retusa* LAM.]: conoflorine (P 4 a), GANZINGER & HESSE (1976); (−)-coronaridine (H 5 a, β); (−)-heyneanine (H 5 a, β), reference no. 248 in KISAKÜREK & al. (1983); (−)-hydroxyindolenine-coronaridine (H 5 a, β); (±)-ibogamine (H 5 a, α+β), HOIZEY & al. (1970); 3-oxo-voacangine (H 5 a), reference no. 248 in KISAKÜREK & al. (1983); (−)-voacangine (H 5 a, β), LE MEN-OLIVER & al. (1974); voacristine (H 5 a), reference no. 248 in KISAKÜREK & al. (1983).

Table 1 (continued)

T. riedelii MUELL. ARG.: (+)-minovincine (P 5 a, β); (+)-3-oxo-minovincine (P 5 a, β); (+)-vincadifformine (P 5 a, β), GANZINGER & HESSE (1976).

T. rigida (MIERS) LEEUWENBERG [= *T. macrophylla* MUELL. ARG. non POIR.; *Anacampta rigida* (MIERS) MGF.; *Phrissocarpus rigidus* (MIERS)]: (+)-apo-vincamine (E 5 a, α); (−)-16-epi-vincamine (E 5 a, β); (±)-16-epi-vincamine (E 5 a, α+β); (+)-vincamine (E 5 a, β), CAVA & al. (1968 a).

T. rupicola BENTH.: (−)-rupicoline (H 6 a); (−)-voacristine-pseudoindoxyl (H 6 a, β); NIEMANN & KESSEL (1966).

T. sessilifolia BAK. [= *Muntafara sessilifolia* (BAK.) PICHON]: (−)-coronaridine (H 5 a, β); (−)-dregamine (C 5 a, α); (−)-eglandine (H 6 b, β); (−)-3,6-oxido-isovoacangine (H 6 b, β); (−)-6-hydroxy-3-oxo-isovoacangine (H 5 a, β), PANAS & al. (1975).

T. siphilitica (L. f.) LEEUWENBERG [= *T. longifolia* BENTH.; *T. tetrastachya* H. B. K.; *Bonafousia speciosa* (POIR.) BOITEAU; *B. tetrastachya* (H. B. K.) MGF.; *Echites siphilitica* L. f.]: (−)-apparicine (A 4 b), DAMAK & al. (1981); (−)-bis-(11-hydroxycoronaridinyl) (H 5 a−H 5 a, β−β), DAMAK & al. (1976); (−)-bonafousine (H 5 a−B, β), DAMAK & al. (1980); 4 (−)-coronaridine (H 5 a, β), DAMAK & al. (1976); geissoschizine (C 3 a); (−)-12-hydroxy-vincadifformine (P 5 a), DAMAK & al. (1981); (+)-iso-bonafousine (H 5 a−B, β), DAMAK & al. (1980); iso-voacangine (H 5 a); pleiocarpamine (C 4 f); tetrahydroalstonine (C 4 a); (−)-tetrastachyne (H 5 a−P 5 a); tubotaiwine (A 4 a); vincadifformine (P 5 a), DAMAK & al. (1981); (−)-voacangine (H 5 a, β), DAMAK & al. (1976).

T. sphaerocarpa BL. [= *T. javanica* MIQ.; *Pagiantha sphaerocarpa* (BL.) MGF.]: dregamine (C 5 a); tabernaemontanine (C 5 a), BISWAS (1973).

T. stellata PICHON [= *Pandaca stellata* (PICHON) MGF.]: (−)-coronaridine (H 5 a, β), HOIZEY & al. (1970).

T. undulata VAHL [= *Bonafousia undulata* (VAHL) A. DC.]: conoflorine (P 4 a), GANZINGER & HESSE (1976); (−)-coronaridine (H 5 a, β); 19-epi-heyneanine (H 5 a); quebrachidine (C 5 c); (−)-voacangine (H 5 a, β), BRUNETON & al. (1979).

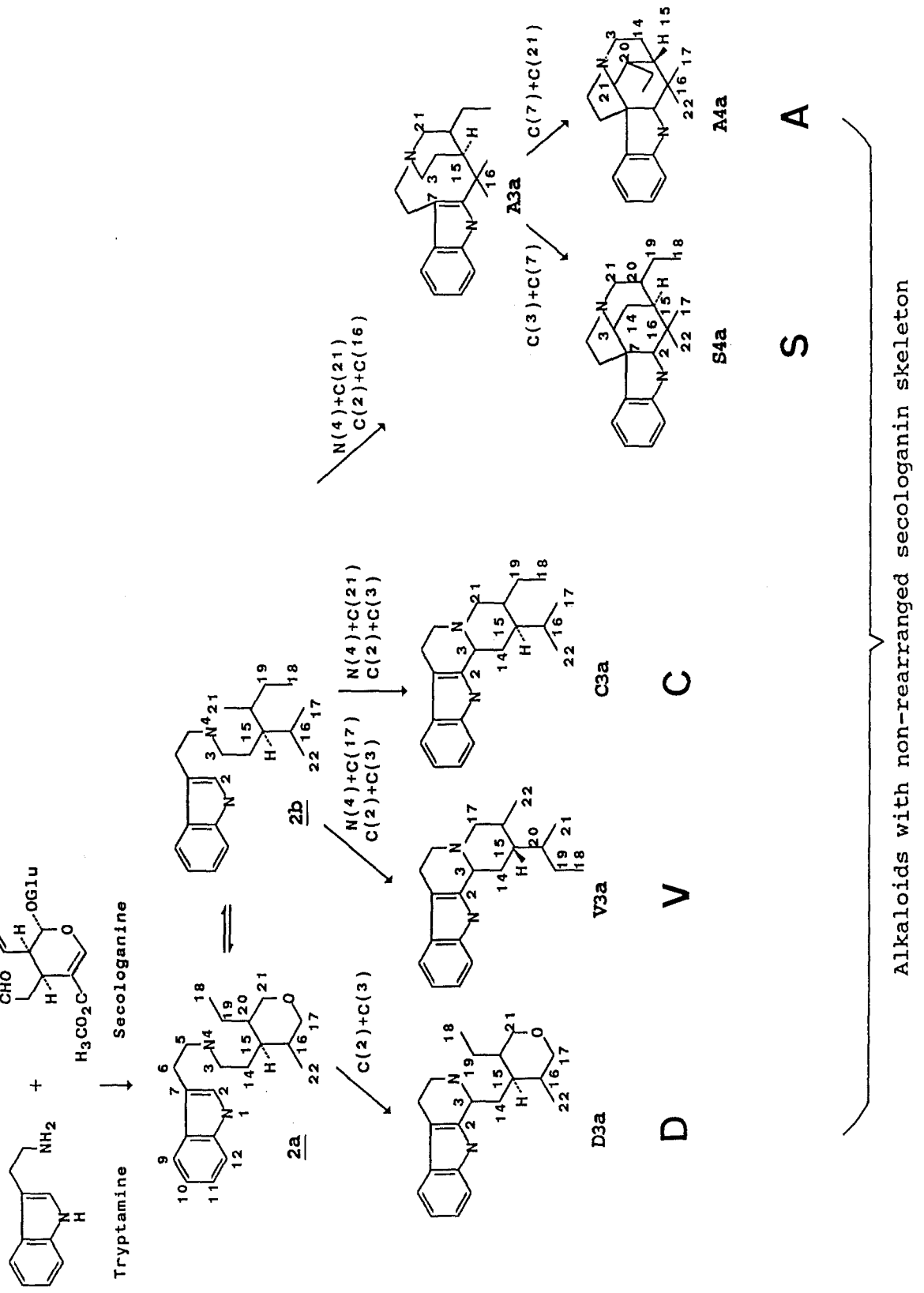
without proof of the chemotaxonomic aspects. Since 1978 a large number of additional alkaloid isolations from the genus *Tabernaemontana* has been published (ZHU 1988). On the bases of these data we would like to re-investigate the genus *Tabernaemontana* under the aspect of chemotaxonomy. The genera listed in Table 2 (nearly 100) are the "old" ones, as mentioned above, since 1983 all of them belong to the genus *Tabernaemontana.*

The sekeletal types of indole alkaloids[1, 2]

Indole alkaloids with secologanin part were classified by KISAKÜREK & al. (1983) into eight main groups, namely: vincosan (abbreviation D), corynanthean (C), vallesiachotaman (V), strychnan (S), aspidospermatan (A), eburnan (E), plumeran

[1] Indole alkaloids are defined as the natural organic products containing either the indole nucleus or an oxidized, reduced or substituted equivalent. They are built up from tryptamine (or tryptophan) and a C_9- or C_{10}-monoterpene moiety, derived from secologanin. By this definition the so-called *Aristotelia* alkaloids are excluded (KYBURZ & al. 1984).

[2] Isolation: When a particular alkaloid was isolated from several different plant species


Tryptamine
Secologanine
2a
2b
C(2)+C(3)
N(4)+C(17)
C(2)+C(3)
N(4)+C(21)
C(2)+C(3)
N(4)+C(21)
C(2)+C(16)
C(3)+C(7)
C(7)+C(21)
D3a
V3a
C3a
A3a
S4a
A4a
D
V
C
S
A
Alkaloids with non-rearranged secologanin skeleton

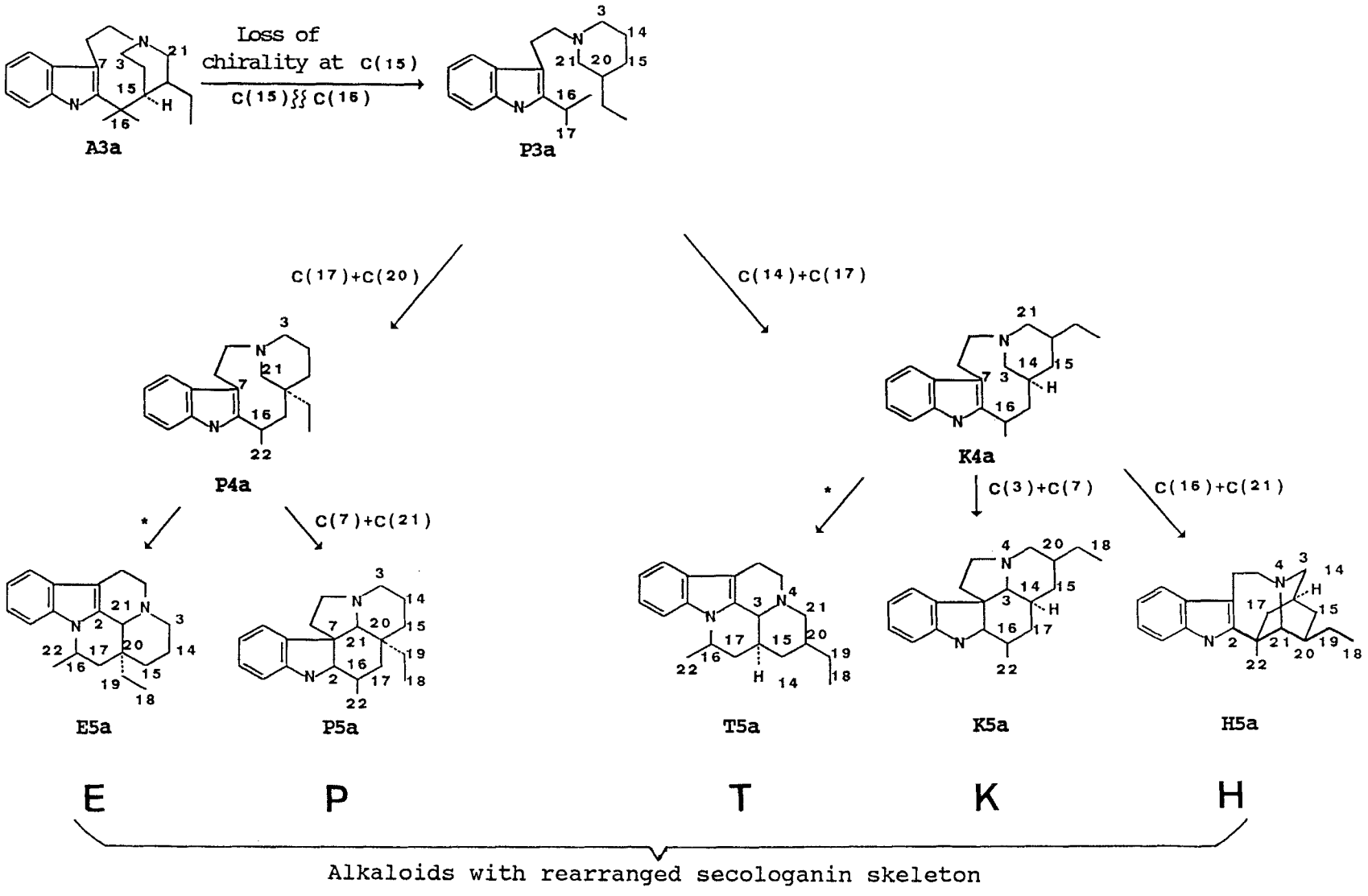
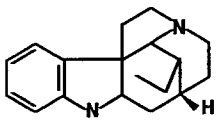
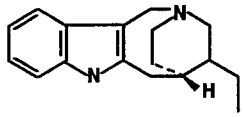


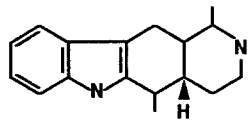
Fig. 1. Biogenetic development of indole alkaloids, presented by their main groups (D, V, C, S, A, E, P, T, K, and H with absolute configuration)



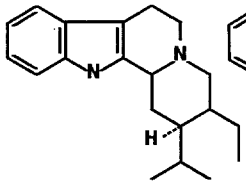
A4a



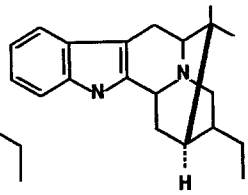
A4b



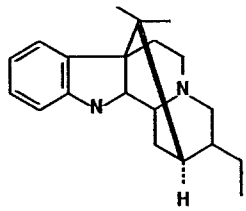
A4d



C3a



C4c



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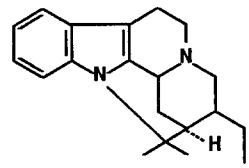
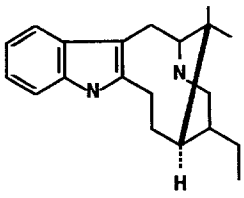


C4f



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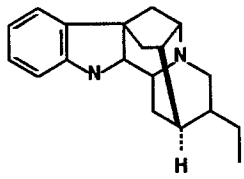

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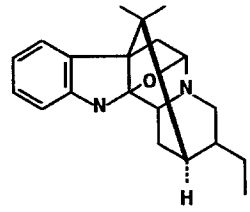

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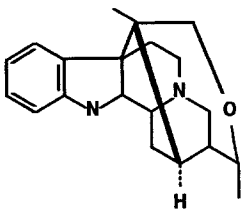

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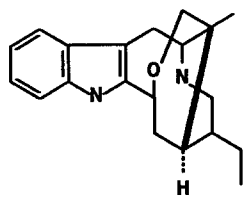

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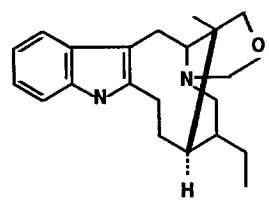

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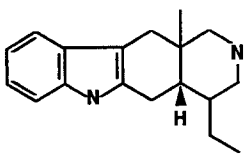

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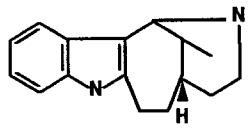

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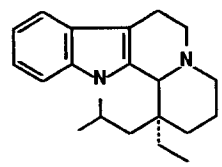

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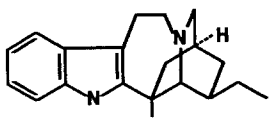

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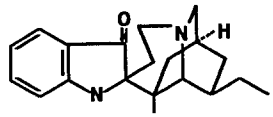

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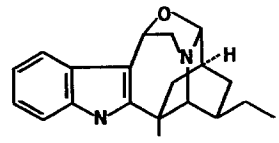

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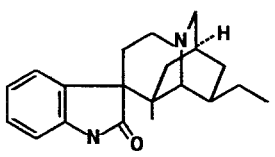

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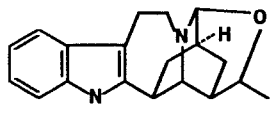

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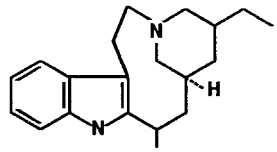

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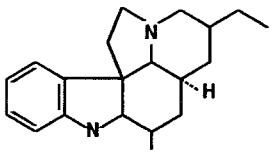

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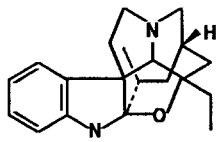

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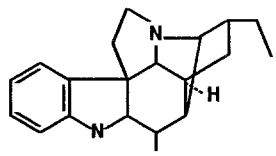

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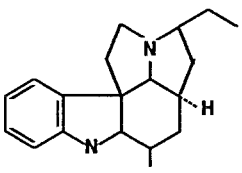

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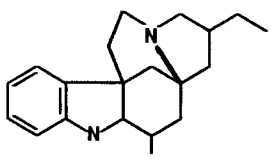

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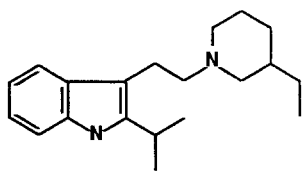

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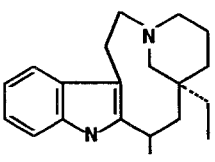

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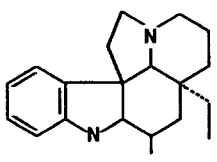

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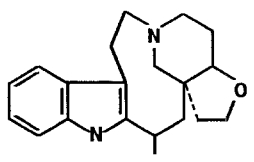

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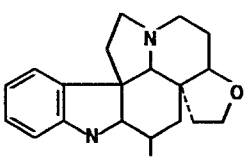

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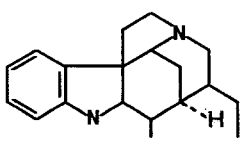

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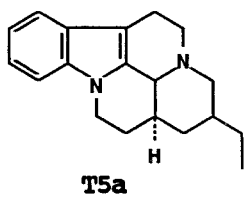

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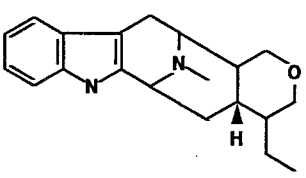

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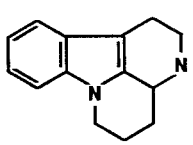

B*

Fig. 2. Skeletal types of which the alkaloids were isolated from the genus *Tabernaemontana* in absolute configuration

(P), and ibogan (J) (Fig. 1). According to new structure types and to biogenetic considerations we prefer to divide the ibogan group (J) into two new main groups: heynean (H) and capuronan (K). Alkaloids of another new main group, named tacaman (T)[3], were recently isolated from plant sources (BEEK & al. 1984 c). Therefore the main alkaloid type J will not be used anymore. We have now to consider the following ten main groups: C, D, V, A, S, E, P, T, H, and K. A simplified biogenetic pathway for these main skeletal types of indole alkaloids is given in Fig. 1.

According to this postulation the alkaloids of H and K type are developed parallel to those of E, P, and T. They belong to indole alkaloid types which, in the chemical sense, are the most complex ones, concerning their "starting materials" tryptamine and secologanin, and therefore they are the most developed. The main groups are divided into subgroups, for instance all alkaloids of the main group C are developed from alkaloids of the skeletal type C 3 a (see Fig. 1). The number shows the grade of development, so C 5 a is more developed than C 4 a. The small letters represent an (alphabetic) order of the skeletal types. All the structures of these types isolated from *Tabernaemontana* are drawn in Fig. 2.

Results

The most important "old" genera are listed in Table 2 together with the main skeleton types of the alkaloids which were isolated from the species. From the chemotaxonomic point of view the whole genus *Tabernaemontana* looks very similar: There are two alkaloid types which are found to be present in all of these genera: types C (exception *Anacampta*) and H (exception *Capuronetta*). Type C has no special indication. It is a basic one which can be found in all genera producing indole alkaloids. The subfamilies *Carisseae, Tabernaemontaneae, Plumerieae*, and *Rauvolfieae* of the *Apocynaceae, Gelsemieae* and *Strychneae* of the *Loganiaceae*, as well as *Cinchonoideae* and *Guettardoideae* of the *Rubiaceae*, all contain indole alkaloids of type C. Much more specific is the occurrence of type H. Alkaloids of this type were isolated from plants of subfam. *Tabernaemontaneae*, which is by far the main source, and from a few plants belonging to the three other subfamilies of the *Apocynaceae*, mentioned above. The alkaloids of the other structure types A and P do occur in all subfamilies of the *Apocynaceae*, for which they are characteristic, too.

One of the factors for the differentiation between the "old" genera is the distribution of alkaloids of the main group K. They belong, like those of H, to the highest developed indole alkaloid types. The occurrence of type K is restricted to the tribe *Tabernaemontaneae* and to the genus *Catharanthus* of the tribe *Alstonieae*, in which all alkaloids of the main group K occur only as part of bisindole alkaloids. It can be recognized that the alkaloids of the main group K were exclusively found in specimens of *Capuronetta, Ervatamia, Pandaca, Stenosolen* (only one species

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(e.g. ten) it was counted as one "alkaloid" but ten "isolations". – The detection of a particular alkaloid from the same source including synonyma reported by different authors is considered as only one isolation.

[3] The main group T has until now only little value for the chemotaxonomy because only a few alkaloids of this group have been isolated.

Table 2. The indole alkaloid content of *Tabernaemontanoideae*. [a] One bisindole alkaloid is counted as two (mono)indole alkaloids. [b] Because of some identities the number of new *Tabernaemontana* spp. is not the sum of single genera species

Genus	Number of species investigated	Number of bisindole alkaloids isolated	Number[a] of alkaloid isolations	Main type alkaloids in percent of the total alkaloid content					
				C	H	K	A	P	others
Anacampta	3		15		67			7	26
Bonafousia	3	3	21	19	52		10	19	
Capouronetta	1	4	12	33		67			
Conopharyngia	17	26	119	33	61		2	4	
Ervatamia	14	18	116	23	51	3	8	14	1
Gabunia	10	7	60	19	49	13	1	3	15
Hazunta	6	3	32	50	19		9	22	
Muntafara	1		5	20	80				
Pagiantha	5		26	12	69		15	4	
Pandaca	12	8	69	22	41	30	6	1	
Peschiera	6	11	50	54	46				
Stenosolen	1	12	38	16	24	26	10	24	
"old" *Tabernaemontana*	22	21	187	26	55		7	10	2
"new" *Tabernaemontana*	[b]	113	750	27	50	7	6	8	2

investigated for alkaloids), and in *Gabunia eglandulosa*. According to the distribution of the alkaloids of the group K the (new) genus *Tabernaemontana* could be at least divided into two parts: one containing alkaloids of type K, and the other one has no K-alkaloids (Table 2). To the second group belong such genera as *Conopharyngia, Hazunta, Pagiantha*, and *Peschiera*. In *Pagiantha* so far no bisindole alkaloids were found. In this respect *Pagiantha* together with *Anacampta* and *Muntafara* are exceptions within the "old" genera.

It is of interest for systematics to consider in an individual genus the ratio of the alkaloids of a special type to the total number of alkaloids isolated from this genus. For example in *Conopharyngia* 61% of all alkaloids belong to the main type H, whereas in *Hazunta* only 19% contain H-alkaloids. Comparing the plants by their alkaloid content most of the genera can be differentiated from each other. The African genus *Gabunia* is phytochemically very interesting and contains alkaloids of the main groups C and H only. The species *G. eglandulosa* STAPF which was collected in Tansania (Africa), contains also only alkaloids of C and H type (AGWADA & al. 1975). But the same species which was grown in a green house in the Netherlands, contains besides alkaloids of the main groups C and H in addition K, A, P, S, and T. Until now alkaloids of the main group T were only isolated from this plant. The change of the alkaloid composition can be explained by the different environment which affects the growth of the plant. Recently it was suggested to upgrade the tribe *Tabernaemontaneae* together with the tribe *Ambelanieae* to a new subfamily "*Tabernaemontanoideae*" (FALLEN 1986). We can partly support this suggestion from a chemotaxonomic point of view. Alkaloids of the main group H occur mainly in the tribes *Tabernaemontaneae* and *Ambelanieae*. It can be assumed that, as mentioned above, the biogenetic development of the types H and K went

parallel to those of P and E. The latter alkaloids are found in all tribes of subfam. *Plumerioideae* (KISAKÜREK & al. 1983). The distribution of the main groups can be used as markers for the plant taxonomy. It was shown that the alkaloids with rearranged secologanin part (main groups E, P, H, K, and T, Fig. 1) only occur in plants of *Apocynaceae* (KISAKÜREK & al. 1983, ZHU 1988). The different distribution of these main groups can be used for further classification within this plant family. P- and E-alkaloids are not as specific as H and K.

In our opinion, based on chemotaxonomy, the relative uniformity of the alkaloid endowment of the tribe *Tabernaemontaneae* is no sufficient argument to create a new subfamily. There is no doubt that a new subfam. *Tabernaemontanoideae* would be in very close relationship to *Plumerioideae*. The other two subfamilies, *Cerberioideae* and *Apocynoideae*, are much more separated from each other and well distinguishable from *Plumeroideae* and *Tabernaemontanoideae*.

The two ideas – creating a new subfamily (*Tabernaemontanoideae*) and combining many genera (see Table 2) to the new genus *Tabernaemontana* – are an expression of the difficult taxonomy of these plants. To improve the taxonomic situation we propose a third way: The classification of the *Apocynaceae* into the three known subfamilies (*Plumerioideae, Cerberoideae,* and *Apocynoideae*) could remain unchanged. The *Plumerioideae* should be subdivided into two groups, which we will call A and B. Group A contains all subtribes of the *Plumerioideae* as before, except *Tabernaemontaneae* and *Ambelanieae*, which are the tribes of group B. The combination of the "old" genera and the "new" *Tabernaemontana* (KISAKÜREK & al. 1983) should be reconsidered and in some cases revised. On the basis of their indole alkaloid content chemists are able to differentiate a number of the genera which are now combined to one genus (*Tabernaemontana*). It sounds reasonable to find a botanical equivalent for their differentiation. The example of *Gabunia eglandulosa* is a hint that the plants of "new" genera of *Tabernaemontana* are extraordinary sensitive to environmental influences like soil, light intensity, etc. Maybe they change not only their alkaloid content but some morphological traits too when growing under extraordinary conditions.

Support by the "Schweizerischer Nationalfonds zur Förderung der wissenschaftlichen Forschung" is gratefully acknowledged.

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Address of the authors: Dr JI-PING ZHU, ARMIN GUGGISBERG, MARTHA KALT-HADAMOWSKY, Prof. Dr MANFRED HESSE, Organisch-chemisches Institut, Universität Zürich, Winterthurer Strasse 190, CH-8057 Zürich, Switzerland.