

## THE FLAVONOIDS OF *XYLONAGRA* (ONAGRACEAE)

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**Key Word Index**—*Xylonagra*; Onagraceae; Onagreae; flavonoids; flavonols; myricetin; quercetin; chemosystematics.

**Abstract**—*Xylonagra arborea* is a monotypic genus of the tribe Onagreae of the Onagraceae. The species is restricted to the desert regions of central Baja California in western Mexico. Four flavonol glycosides, myricetin 3-*O*-glucoside, myricetin 3-*O*-rhamnoside, quercetin 3-*O*-glucoside and quercetin 3-*O*-rhamnoside were found to occur in methanolic leaf extracts of each of the populations sampled. The data are consistent with earlier investigations of leaf flavonoids in the Onagreae and suggest interesting changes in B-ring hydroxylation patterns within the tribe.

### INTRODUCTION

*Xylonagra* comprises a single species of low shrubs restricted to central Baja California in western Mexico. Although it has been compared with *Hauya* it is in fact a member of the tribe Onagreae [1] and probably reasonably regarded as related to other genera with a more or less spherical stigma and a gametic chromosome number of  $n = 7$ , namely *Gayophytum* and *Camissonia*. It is certainly specialized within the tribe, however, in its winged seeds and red tubular hummingbird-pollinated flowers. As a part of a comprehensive investigation of the flavonoids and trends of flavonoid evolution in Onagraceae we are herein reporting the flavonoids of *Xylonagra*.

### RESULTS

Methanolic extracts from the leaves of four samples of *Xylonagra* yielded four flavonol glycosides based upon the two aglycones myricetin and quercetin. The compounds were identified as myricetin 3-*O*-glucoside, myricetin 3-*O*-rhamnoside, quercetin 3-*O*-glucoside and quercetin 3-*O*-rhamnoside. All four compounds were found to be present in each of the populations sampled.

### DISCUSSION

Most of the previous investigations of the leaf flavonoids of the Onagreae have centered on *Oenothera* [1–4], but two species of *Calylophus*, one each of *Gaura* and of *Camissonia* have been reported. In addition, we have completed studies of the monotypic genera *Stenosiphon* and *Heterogaura* [5, 6]. The compounds found in *Xylonagra* are in general agreement with those previously reported for the Onagreae. It may be noted, however, that kaempferol-based compounds are absent in *Xylonagra*. Within the genera mentioned above kaempferol glycosides are absent, except for individual species, only in

*Oenothera* sect. *Pachylophus*. Flavonoid data for the genera allied to *Xylonagra* are insufficient for general comparisons at this point. The report for the single species of the diverse genus *Camissonia* (reported as *Oenothera tanacetifolia*) was from leaf hydrolysates and only data for the aglycones were reported [2]. Nevertheless, these and other flavonoid data, i.e. the absence of myricetin in sections *Oenothera* and *Raimannia* of *Oenothera*, strongly suggest that there may be considerable intrinsic interest concerning the changes in B-ring oxygenation patterns within the Onagreae.

### EXPERIMENTAL

**Plant material.** Plants were obtained from four populations of *Xylonagra arborea*. The material was air-dried and the leaves removed for extraction. Voucher specimens are as follows and are deposited at the Missouri Botanical Garden (MO). Mexico (Baja California): 3 miles SE. of Punta Prieta, *Moran* 892; 7 miles SW. of Rosarito, *Verity* 32; Cedro I, E. of Gill Peak, *Moran* 10702. U.S.A. (California): Los Angeles Co., cultivated at UCLA Botanical Garden, *Verity* s.n.

**Isolation and identification.** The leaf material was ground and extracted overnight with 85% MeOH and the resulting extract examined by 2-D PC. Certain of the extracts were also examined by TLC (polyamide and cellulose). For structural elucidation, replicate chromatograms were run and the isolated compounds cut from the paper for further purification and analysis. The quantities of leaf material utilized varied but were ca 0.5–1.0 g for screening and ca 5–10 g for replicate chromatograms. Sufficient MeOH was added to just cover the ground leaf material. Identification of the glycosides and their aglycones was accomplished by standard UV spectroscopic, cochromatographic and hydrolytic techniques [7–10].

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## THE FLAVONOIDS OF *STENOSIPHON* (ONAGRACEAE)

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**Key Word Index**—*Stenosiphon*; Onagraceae; Onagreae; flavonoids; flavonols; kaempferol; quercetin; myricetin; chemosystematics.

**Abstract**—*Stenosiphon linifolius* is a monotypic genus of the tribe Onagreae of the Onagraceae. The species is widespread in, but restricted to, the Great Plains of the United States. Three flavonol glycosides, kaempferol 3-O-rhamnoside, quercetin 3-O-rhamnoside and myricetin 3-O-rhamnoside, were found to occur in methanolic extracts of *Stenosiphon* leaves. Similar compounds are found in the leaves of such related genera as *Oenothera* and *Gaura*, but in the latter genera, additional flavonols exhibiting greater substitutional variation also are found.

### INTRODUCTION

Investigations of the flavonoids of Onagraceae, tribe Onagreae have largely been confined to *Oenothera* [1–3], but a few species of *Calylophus* [1, 3], *Camissonia* [2] and *Gaura* [1] have also been examined. In addition, we have just completed a study of the monotypic genus *Xylonagra* [15]. Outside Onagreae, studies have been completed for Epilobieae [5, 6] and Circaeae [7] and studies of Jussiaeae are in progress. As a part of an overall study of the flavonoids in the entire family, we herein report the flavonoids of *Stenosiphon linifolius*.

*Stenosiphon* is a monotypic genus of the Great Plains of the United States and is included in the tribe Onagreae of the family Onagraceae [8, 9]. Specifically, Raven [8] considered it to be more closely related to *Oenothera* than to *Gaura*, with which it had been associated earlier, or to any other genus.

### RESULTS

Methanolic extracts from the leaves of four samples of *Stenosiphon* yielded three flavonol glycosides in relatively equal concentrations. The three compounds were identi-

fied as kaempferol 3-O-rhamnoside, quercetin 3-O-rhamnoside and myricetin 3-O-rhamnoside. The three glycosides are well-known and, in fact, are reported in other genera of the family [1–4, 6, 7]. Nonetheless, each compound was identified by UV spectroscopy, appropriate hydrolyses and cochromatography of the aglycones and glycosides. Absorption maxima and  $R_f$  values correspond with published reports [10, 11].

### DISCUSSION

As noted above, *Oenothera* is the best known genus of the tribe Onagreae with respect to its flavonoid diversity. Ca 50 species representing 10 subgenera have been examined. All of the compounds found in *Oenothera*, as well as in the few samples examined of other genera of Onagreae, have been flavonols: 3-mono- and diglycosides and 3,7-diglycosides, and 3- and 3'-methyl ethers are also present, some 15 compounds in all. The flavonoids isolated from the leaves of *Stenosiphon* are of the same type, but kaempferol 3-O-rhamnoside has not yet been reported in *Oenothera*. The substitutional diversity apparent in some species of *Oenothera*, however, is absent in *Stenosiphon*.