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# Food Selection of the Malayan Tapir (*Tapirus indicus*) Under Semi-Wild Conditions

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**Abstract.** A study on the selection of food plants by captive Malayan tapirs (*Tapirus indicus*) was undertaken in a 30 hectare natural forest enclosure at the Sungai Dusun Wildlife Reserve, Malaysia. Tapirs browsed on 217 species of plants (from 99 genera and 49 families) from a total of the 1142 specimens collected and identified. Food plants were heavily dominated by sapling trees and shrubs which comprised 93% of all plants taken, with the remainder comprising woody lianas, vines and herbaceous plants. Although tapirs browsed on a wide variety of plant species, the top 30 species consumed represented more than 60% of all the plants selected, whilst the vast majority of species were rarely eaten. More than 80 species of trees and shrubs were available, but not eaten at all. The most readily consumed species were the sub-canopy and understorey trees *Xerospermum noronhianum*, *Aporosa prainiana* and *Baccaurea parviflora*, while *Aporosa*, *Knema* and *Xerospermum* were the dominant plant genera. The Phyllanthaceae (leaf flowers), Myristicaceae (nutmegs) and Sapindaceae (rambutans) were the most commonly selected families comprising 45% of the diet. Tapirs fed on saplings trees up to 8.3 m in height, while plants taller than about 1.6 m were bent, broken or pushed to the ground to gain access to the foliage. Sapling stems up to 4.2 cm in diameter could be snapped by biting, while larger trees to 7 cm diameter could be pushed down. Tapirs typically fed on the newer leaves and shoots, however, often only consuming half of the available foliage on a plant. This study documents 160 new plant species suitable as Malayan tapir food, and is consistent with the generalist, but selective browsing nature of the *Tapirus* species in general.

**Keywords:** Malayan tapir, feeding behavior, food selection, ungulate diet.

## INTRODUCTION

The Malayan tapir (*Tapirus indicus*) is one of only four extant tapir species, and the only one to be found in Asia. The current distribution extends from Southern Thailand and Myanmar, through Peninsular Malaysia to Sumatra, Indonesia [1]. It is currently listed as *Endangered* by the IUCN [2], due to population declines predominantly from ongoing habitat loss. Within Peninsular Malaysia, it is widely distributed and found in all habitat types up to 1800 m [3]. Despite the widespread nature of the species, it has received relatively little scientific attention since its description nearly 200 years ago, and its ecology is still poorly understood. Earlier observations and studies have provided some knowledge of feeding ecology, home-range size and habits of the species in Malaysia [4-11]. More recent studies during the last 15 years or so have provided additional information on its ecology and conservation [12,18]. Malayan tapirs are generally nocturnal, solitary animals, feeding on a variety of plant species. The home range may be in excess of 12 km<sup>2</sup> [10,19,20], with the species often being recorded in the lowland dipterocarp forests of Malaysia [3,21-22].

All tapir species are hindgut fermenting herbivores, and as such, are more generalized feeders than their ruminant counterparts [23]. In Malaysia, tapirs are known to feed on the fruits, leaves, buds and stems of a wide variety of forest species (including some cultivated plants) [9,11,20]. Malayan tapirs were recorded feeding on a restricted diet of eight tree species and an herbaceous plant along disturbed forest road [9]. A more comprehensive study in a primary dipterocarp forest of Malaysia reported tapirs feeding on more than 115 species of plants (from 70 genera and 40 families) [11]. Tapirs were said to browse selectively on relatively few of the multitude of available forest species, with plants from the Euphorbiaceae and Rubiaceae making up more than 40% of the diet. Several species of herbaceous plants were also consumed, but only the young leaves were taken, and this in moderation, even when plentiful [11]. Another study, also in a Malaysian dipterocarp forest [20], and a Burseraceae-dominated forest [24],

likewise recorded the most dominant tapir food plants from the families of Rubiaceae and Euphorbiaceae, as well as from the Melastomataceae.

Fruit also makes up a considerable proportion of the diet of all tapirs species [25], although this probably varies considerably with species, habitat and season. The diet of the Malayan tapir in Thailand was said to contain 8.1% fruit [12], while fruit parts were usually present in tapir dung from Taman Negara National Park, Malaysia [11]. The role of Malayan tapirs as seed dispersers has not been fully assessed, although they are known to be poor dispersers of large seeds - with such seeds often not being consumed, damaged by chewing or failing to germinate after passing through the gut [26].

Relatively little information is published on the feeding methods or habits of the Malayan tapir, although it has been noted that tapirs seem to be quite choosy in regard to the quantity of browse taken, selecting only a few leaves from one bush before moving to another [4]. Malayan tapirs also feed on only a fraction of the plants available to them, and can browse foliage to 6.5 m high by pushing or snapping such taller trees down [11]. Snapped stems were typically 0.8-1.2 m in height, and occasionally to 1.4 m, with stem diameters typically less than 2.7 cm at the break [11].

The objectives of this study were to determine the feeding behaviour, and the frequency of species consumed, by Malayan tapirs under semi-wild conditions in a Burseraceae dominated forest.

## METHODS

The present study was undertaken at Sungai Dusun Wildlife Reserve, Malaysia (3°40'N, 101°21'E), and conducted within the Conservation Centre at the western edge of the Reserve. The Wildlife Reserve is comprised of freshwater peatswamp forest in the southwestern portion, with lowland forest generally to the northeast. The Reserve covers an area of some 6000 ha with an elevation less than 250 m. The humid tropical climate has a mean daily (2pm) temperature of 26.8°C [27], without strong drought seasons. Most of the Reserve is old (selectively logged) secondary forest [27], with the Conservation Centre situated in the ecotone of peatswamp and lowland forest. The understorey and ground-level plants are dominated by Burseraceae species, with more than 25% of fruit trees in the lowland and peatswamp forests comprising species from the Burseraceae family [27].

The study was undertaken from October 2010 until March 2011, when two adult captive-bred Malayan tapirs (an 8 year old male and 8.5 year old female) were released into the largest enclosure at the Centre, the 30 hectare paddock. This enclosure measured approximately 1.1 km long and several hundred meters wide and enclosed the natural lowland Burseraceae forest of the area. Although the fenced enclosure was initially established for Sumatran rhinoceros (*Dicerorhinus sumatrensis*) it was never used, and the forest within the enclosure was generally undisturbed by herbivores prior to the introduction of the tapirs. Tapirs were fed each morning at approximately 9am with sufficient food for their daily requirements (including a variety of fruits, sweet potatoes, leaves and commercial horse pellets). An artificial mineral block was placed 300 m from the feeding station and a small natural creek provided water. Tapirs were free move and feed on the native vegetation throughout the enclosure.

All forest plants showing signs of being bitten or browsed by tapirs were labeled and leaf voucher specimens collected. Specimens were then pressed, dried and identified to species, if possible. Plant nomenclature followed that of "The Plant List" (<http://www.theplantlist.org>) a collaborative project of The Royal Botanic Gardens, Kew and Missouri Botanical Garden. Browsed plants were collected randomly throughout the enclosure, and also from five (5) line transects. Each transect measured 250 m long and plants of suitable browsing height were collected (whether browsed or not). Most eaten plants were measured for height, stem diameter (at 50 cm high), percentage and height of available browsed vegetation and height/diameter of snapped stems. Uneaten plants (with foliage lower than 2.5 m) were also collected from within 1.5 m of some browsed vegetation. Due to the large size of the enclosure, it was not possible to locate and identify all tapir feeding signs, however it is assumed that the samples collected adequately reflect the food plants eaten by these captive tapirs. It was not possible to directly observe the tapirs feeding due to the dense vegetation and their avoidance behaviour. All feeding behaviour and aspects of diet were thus inferred through the detection and assessment of feeding signs.

## RESULTS

### Food Plants of the Malayan Tapir

A total of 1142 plants showing signs of browsing by tapirs were collected and identified. These specimens represented 217 species from 99 genera in 49 families. Browsing was generally not concentrated to any particular area of the enclosure. Based on plant habit or form, the browsed specimens were heavily dominated by tree species, which comprised 69.6% of all plants collected (FIGURE 1). Of the top 30 most readily eaten species (TABLE (1)), trees were highly represented by 28 species, shrubs one species and one species of woody liana. Tapirs typically browsed on the leaves, shoots, twigs and branches, and very rarely chewed the bark. We did not attempt to document fruit, bud or flower consumption, as the majority of browsed vegetation were of immature specimens.

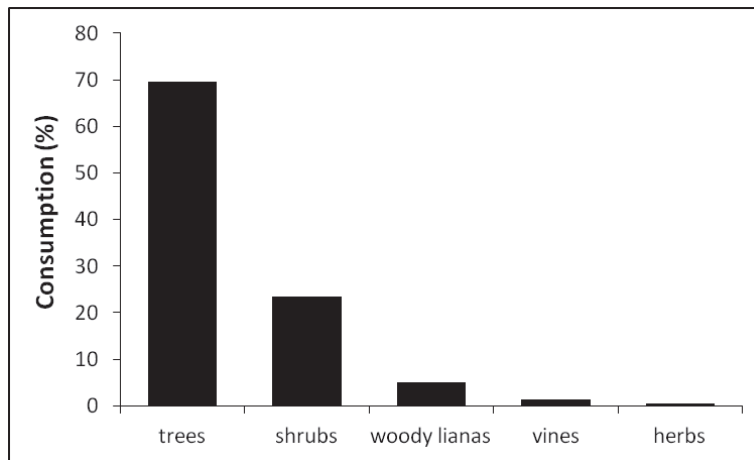


FIGURE 1. Composition of plant forms in the diet of semi-wild Malayan tapirs (217 sp.).

TABLE (1). The 30 most frequently consumed plant species by Malayan tapirs in the 30 hectare enclosure at the Sungai Dusun Conservation Center, Malaysia. % Eaten are percentages of total consumed plants (n=1142).

Rank	Family	Species	% Eaten
1	Sapindaceae	<i>Xerospermum noronhianum</i>	11.2
2	Phyllanthaceae	<i>Aporosa prainiana</i>	8.2
3	Phyllanthaceae	<i>Baccaurea parviflora</i>	6.9
4	Myrtaceae	<i>Syzygium</i> sp1	3.3
5	Myrtaceae	<i>Syzygium pycnanthum</i>	3.1
6	Myristicaceae	<i>Knema kunstleri</i>	2.8
7	Cannabaceae	<i>Gironniera nervosa</i>	2.8
8	Phyllanthaceae	<i>Aporosa symplocoides</i>	2.7
9	Myristicaceae	<i>Knema patentinervia</i>	2.6
10	Burseraceae	<i>Dacryodes costata</i>	2.3
11	Myristicaceae	<i>Knema hookeriana</i>	2.2
12	Olacaceae	<i>Ochanostachys amentacea</i>	2.0
13	Polygalaceae	<i>Xanthophyllum rufum</i>	2.0
14	Melastomataceae	<i>Dissochaeta gracilis</i>	1.8
15	Melastomataceae	<i>Pternandra echinata</i>	1.8
16	Myristicaceae	<i>Knema furfuracea</i>	1.8
17	Burseraceae	<i>Santiria rubiginosa</i>	1.7
18	Clusiaceae	<i>Garcinia eugeniiifolia</i>	1.5
19	Myristicaceae	<i>Knema stenophylla</i>	1.3
20	Myristicaceae	<i>Knema laurina</i>	1.2
21	Myrtaceae	<i>Syzygium filiforme</i>	1.2
22	Rubiaceae	<i>Ixora kingstonii</i>	1.2

23	Phyllanthaceae	<i>Baccaurea brevipes</i>	1.1
24	Rubiaceae	<i>Timonius wallichianus</i>	1.0
24	Sapindaceae	<i>Xerospermum laevigatum</i>	1.0
26	Thymelaeaceae	<i>Gonystylus confusus</i>	1.0
27	Phyllanthaceae	<i>Baccaurea minor</i>	0.9
28	Clusiaceae	<i>Garcinia nigrolineata</i>	0.9
29	Phyllanthaceae	<i>Aporosa benthamiana</i>	0.8
30	Phyllanthaceae	<i>Aporosa nigropunctata</i>	0.8

Although tapirs consumed a wide variety of plant species, the vast majority of these species were eaten infrequently. Nearly 90% of all species consumed were browsed less than 10 times, with more than 120 species (of the 217) eaten only once or twice. In contrast, the dominant 30 species were frequently consumed with *Xerospermum noronhianum* being taken more than 100 times. These 30 dominant species (14% of all species consumed) alone represented 63% of all the 1142 plants taken (TABLE (1)). The sub-canopy and understorey trees *Xerospermum noronhianum*, *Aporosa prainiana* and *Baccaurea parviflora* were most readily selected.

The ten most frequently consumed genera were *Aporosa* (11.5%), *Knema* (11.3%), *Xerospermum* (10.4%), *Syzygium* (8.6%), *Baccaurea* (8.2%), *Garcinia* (3.6%), *Gironniera* (3.3%), *Dacryodes* (2.8%), *Xanthophyllum* (2.5%) and *Pternandra* (2.4%). These top ten genera (or 10% of all genera consumed) comprise about two thirds of all plants selected.

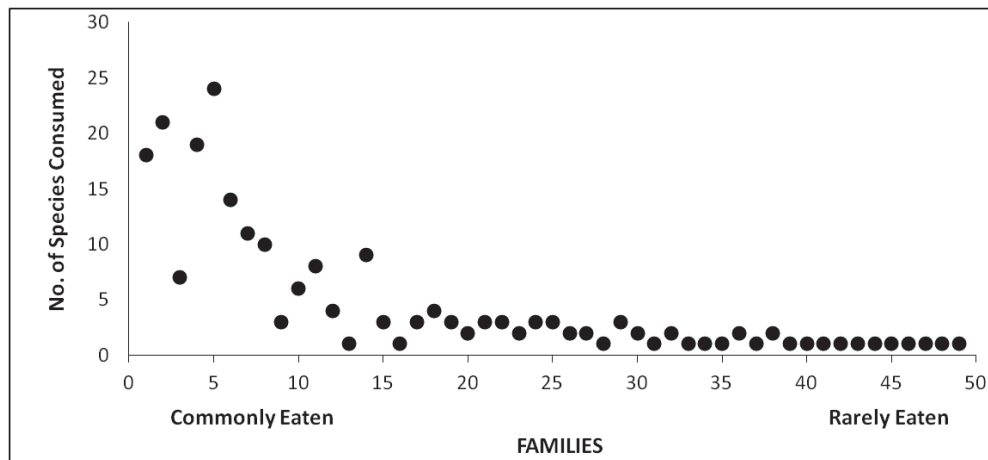
The families of Phyllanthaceae, Myristicaceae and Sapindaceae were dominant in the diet, with these 3 families alone representing 45% of all plants taken (TABLE (2)). Ninety percent (90%) of all selected plants were represented by just 15 of the 49 consumed families. There was a significant positive relationship between the number of species consumed from within a family, and the dominance of that family in the diet (by plant abundance) ( $r=0.820$ ,  $n=49$ ,  $p<0.0001$ ). Typically families were dominant in the diet because plants were consumed from a larger number of species, rather than many plants from few species (FIGURE 2). Conversely, rarely eaten families usually comprised of only one or two species. Although the understorey forest within the enclosure is dominated by species of the Burseraceae family (~17% of understorey plants), only 5.6% of all plants consumed were from the Burseraceae family, indicating a discriminate feeding pattern.

**TABLE (2).** The most frequently consumed plant families (and their corresponding consumed species) by Malayan tapirs in the 30 hectare enclosure at Sungai Dusun Conservation Centre, Malaysia. % Eaten are percentages of total number of consumed plants (n=1142).

Rank	Family	% Eaten	# Species Consumed
1	Phyllanthaceae	20.2	18
2	Myristicaceae	13.7	21
3	Sapindaceae	11.1	7
4	Myrtaceae	8.6	19
5	Rubiaceae	6.8	24
6	Melastomataceae	6.3	14
7	Burseraceae	5.6	11
8	Clusiaceae	3.6	10
9	Cannabaceae	3.3	3
10	Polygalaceae	2.5	6
11	Moraceae	2.1	8
12	Calophyllaceae	1.9	4
13	Olacaceae	1.7	1
14	Leguminosae	1.4	9
15	Rosaceae	1.4	3

More than 80 species of plants (from 35 genera in 15 families) were also identified as available to tapirs - and found close to browsed plants - but were not eaten at all. Some of these species were within the same family or genera as plants that were readily eaten. For example, three species from the genus *Dacryodes* (Burseraceae) were readily eaten, on 32 occasions (*D. costata*, *D. incurvata* and *D. rubiginosa*), while *D. kingii*, *D. laxa*, *D. rostrata* and

an unidentified *Dacryodes* sp. were not eaten at all (34 samples). Not all individuals of consumed species would be eaten along a trail. Transect work suggested that plants were often bypassed and left uneaten, even for species which were frequently eaten or common in the diet.



**FIGURE 2.** The number of species consumed by tapirs per plant family. Plant families are ranked according to the abundance of plants consumed; from common to rare. The first 15 ranked families (and their corresponding number of consumed species) are shown in TABLE (2).

### Feeding Behaviour

Tapirs browsed on a wide variety of species, but rarely was all the available foliage eaten for a particular species. From more than 500 plants assessed, only 62% (on average) of available branches were consumed. Even for the most commonly selected species, only about half of all available foliage was eaten (*Xerospermum noronhianum* 54%, *Aporosa prainiana* 57% and *Baccaurea parviflora* 50%). Typically the amount of foliage consumed differed from plant to plant, and often ranged at 10-100% for a particular species. Such a result indicates that the proportion of the plant consumed does not equate or infer preference for that particular species, especially if assessing small sample sizes. A Pearson correlation analysis showed there was no correlation between plant height and proportion of foliage consumed for either the 10 most readily consumed plants ( $p=0.315$ ) or all assessed plants ( $p=0.784$ ). Even when only considering standing plants below 1.5m high, that is, plants with all available leaves easily reachable, there was no significant correlation between amount of browse consumed and plant height ( $p=0.879$ ).

When tapirs fed on shorter plants, and could reach the top of these trees (less than 1.5m tall), they would usually (on 89% of occasions) eat the younger and newer crown leaves on top of the plant, as well as other leaves. However, when browsing on taller trees which were knocked to the ground (see below), tapirs only fed on the crown leaves on 37% of occasions. This difference may be explained if crown leaves were only taken due to their accessibility, and were not specifically targeted by the tapir to obtain the newer, younger leaves. As crown leaves were easily accessible in shorter plants, they may have been consumed more often, while larger plants, knocked to the ground, typically had larger amounts of foliage to browse from, and thus crown leaves need not be targeted. Uneaten leaves and branches were typically lower on the stem, which may indicate some selection for newer (or younger) foliage.

Tapirs showed four main strategies for obtaining and browsing foliage. Leaves that could be easily accessed, up to about 1.5 m in height, were browsed without further disturbance to the plant. All small plants were browsed in this manner. For taller and more flexible trees between 1.5 m and 2.3 m, the tapirs could reach and eat the higher foliage by bending the tree down by biting and pulling on the stem. Numerous teeth marks were usually seen along the main stem of these trees, typically at heights from 100 cm to 160 cm. Where the tree was taller than about 1.5 m and the stem was relatively stiff and inflexible, tapirs would snap the main stem by biting and bending until the stem snapped. Trees up to 5.5 m tall could be snapped in this manner to gain access to the higher foliage. The average broken stem height was 97 cm (SD 23.6 cm; range 15-183 cm), while the average thickness of the stem at the break was 17 mm (SD 6.6 mm), with a maximum break diameter recorded of 42 mm. Taller trees, up to 8.3 m, could be pushed to the ground by tapirs (probably using their bodies) and it is possible that the tapir also used its mouth to bite and pull or push the tree until it was knocked down. Most trees knocked down in this manner had teeth marks along the main stem at various sites above 0.8 m. For example, a 6.5 m tree had teeth marks at 2.6 m, 2.8 m, 2.9 m,

3.5 m and 4.5 m along the main stem. Trees knocked over in this manner were up-rooted, and often lay horizontal on the ground. These trees had an average diameter of 39 mm, with the maximum recorded of 71 mm. We found no foot marks on the lower stems to suggest that the trees had been trampled or walked-down as noted by Williams and Petrides [11].

## DISCUSSION

This study contributes significantly to the list of acceptable food plants of the Malayan tapir, by documenting an additional 160 new species. Including in this study, Malayan tapirs are now known to feed on at least 380 species of plants [8,10,20,24]. An increasing number of species are likely to be added to food lists as further studies (particularly in different habitats) are undertaken. Studies of the Lowland tapir (*T. terrestris*) suggest that they feed on 215 species of plants and >200 species of fruits, but that food lists are far from complete, and it is likely (based on species accumulations curves and Chao2 estimators) that Lowland tapirs may in fact consume at least 347 species (and maybe more than 800) [28-29].

Three species of favoured plants from the dipterocarp forest of Malaysia (*Aporosa praineana*, *A. symplocoides* and *Baccaurea parviflora*) [11] were also recorded in the top 10 selected species of the Burseraceae forest of this study. There was, however, generally little species similarity of consumed plants between the two forest types, as many species found in the dipterocarp forests were absent or found in low densities in the forest of this study - and thus did not feature prominently as tapir food. Plants from the families of Euphorbiaceae, Rubiaceae and Melastomataceae were readily eaten by wild tapirs in the lowland dipterocarp forests of Malaysia [11,20]. It is interesting to note that the Rubiaceae and Melastomataceae were also dominant in the diet of Lowland tapirs in French Guiana [29]. We also found plants from Rubiaceae and Melastomataceae readily consumed (ranked 5 and 6 respectively), however the Phyllanthaceae family (18 species; 20% of all consumed plants) was the most commonly consumed family group in this study, along with the Myristicaceae and Sapindaceae. The Phyllanthaceae, however, is relatively new, having been recently split from the Euphorbiaceae [30], thus many species recorded in previous studies as Euphorbiaceae, are now in the Phyllanthaceae family.

Captive tapirs in an adjoining 4-ha enclosure at the Conservation Centre consumed 88 genera and 113 plant species [24]. There was however very little species similarity with plants consumed in this study. Of the top 12 species browsed in the 4-ha enclosure, the highest species ranked only #50 in this study. It is also noted that seven of these top 12 species were not even consumed in the present study. The major difference in these two studies can probably be attributed to the state of the forests of the two enclosures. The 4-ha enclosure had been used for many years by both rhino and tapirs, and thus would probably be exhausted of preferred or commonly eaten wild food species. The tapirs in this enclosure nevertheless consumed many of the shrubs, trees, and herbs. Such browsed plants probably do not represent “preferred” species but do reflect the wide range and breadth of plants that tapirs are able to consume. In contrast, the forest within the adjoining 30-ha enclosure of this study, was undisturbed by browsers, and therefore the top species consumed here would probably comprise the tapirs’ naturally selected species from this habitat type.

More than 80 species of trees and shrubs were documented close to browsed plants but not eaten at all, while plants of the most common family (the Burseraceae, comprising 17% of understorey plants) were rarely eaten. Such a selective feeding strategy indicates that the Malayan tapir does not indiscriminate in its food choice. Studies of *T. pinchaque* and *T. terrestris* have shown very selective feeding behaviour, with often abundant species being rarely selected [31-32]. A captive Baird’s tapir (*T. bairdii*) was also very selective in its food choice, even while consuming plants from more than 170 species [33]. Even favoured species would only be eaten in moderation in a single meal [33]. Such a behaviour may account for the fact that many readily eaten plants along the transect lines of this study were not consumed. Tapirs in general, seem to select various plant species from the great number available, eating moderately from each plant, rather than gorging itself on a few select species or individual plants. This selective behaviour was highlighted by Sanborn and Watkins [4] in Malaysia more than 60 years ago with the comments “...taking a few leaves from one bush and then moving on to another” and “... never eating all the leaves on a bush.” Such a feeding strategy may prevent an overload from the effects of toxic secondary plant compounds, and/or reduce plant death from over-browsing.

Malayan tapirs show a typical generalist feeding behaviour, however are particular in what they consume, browsing on selected species, plants and plant parts, from the great array of forest vegetation. The ability of Malayan tapirs to feed on a wide diversity plant species may be an adaptation to provide the large quantities of the more abundant low-quality forage that is typical for non-ruminant herbivores [23], such as the tapir. Diversifying the range of food plants, may also reduce the potential for poisoning the body with an overload of toxic compounds that

are produced by many plant species [34], and thus allow the Malayan tapir to inhabit the wide range of habitat types in which it is found. We consider the plant species consumed in this study – from natural forest and typical tapir habitat - to be representative of the food plants that would be eaten by wild Malayan tapirs.

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