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Explanation of Nymphalidae Butterflies

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Abstract

The Nymphalidae is a family of several thousand species found in all zoogeographical regions of the world. Most are medium or large in size, but the family is highly variable given that it also includes the *Satyrinae*, a subfamily that has been designated as a family in its own right in earlier classifications. The forelegs in both sexes are vestigial and useless for walking. In the male, there are typically only 2 tarsal joints and the legs have a brush-like appearance, resulting in a common name for this family - the "brush-footed butterflies". The female foreleg has 4 tarsal joints which, when compared with the male, provides a mechanism of determining the sex of the adult. The midleg and hindleg are normal in both sexes and both tibia and tarsus may have spines. This family is represented by the following subfamilies: Danainae; Satyrinae; Morphinae; Heliconiinae; Limenitidinae; Apaturinae and Nymphalinae.

Keywords: Brush-Footed Butterflies; Danainae; Monarch; Gatekeeper

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Introduction:

Butterflies of family: Nymphalidae are with reduced forelegs. The reduction in the length of forelegs is the most significant, which made them to appear as if with only two pairs of legs (mesothorasic and metathorasic). Therefore, butterflies of family: nymphalidae are also called as "Four Footed Butterflies". Reduction of the first pair of legs (prothorasic legs) in butterflies of family: nymphalidae appears particularly extensive in the femur. Remaining two pairs of legs (mesothorasic and metathorasic) in nymphalidae are frequently hairy and resemble brushes. The "Feather legged butterflies", alternative name derives from the fact of hairy or feathery legs of these butterflies. The Nymphalidae is with about six thousand species distributed throughout most of the world. These butterflies are usually medium-sized to large butterflies. Most species of family: Nymphalidae have a reduced pair of forelegs and many hold their colourful wings flat when resting. The butterflies of family: Nymphalidae are also called brush-footed butterflies or four-footed butterflies, because they are known to stand on only four legs while the other two are curled up; in some species, these forelegs have a brush-like set of hairs which gives this family its other common name.

Many species of family: Nymphalidae are brightly coloured and include popular species such as the emperors, monarch butterfly, admirals, tortoiseshells, and fritillaries. However, the under wings of the members of family: Nymphalidae are, in contrast, often dull and in some species look remarkably like dead leaves, or are much paler, producing a cryptic effect that helps the butterflies blend into their surroundings. Rafinesque (1815) introduced the name Nymphalia as a subfamily name in diurnal Lepidoptera. Rafinesque did not include *Nymphalis* among the listed genera, but *Nymphalis* was unequivocally implied in the formation of the name (Code Article 11.7.1.1). The attribution of the Nymphalidae to Rafinesque has now been widely adopted (Vane-Wright & de Jong, 1978). In the adult butterflies, the first pair of legs is small or reduced, giving the family the other names of four-footed or brush-footed butterflies. The caterpillars are hairy or spiky with projections on the head, and the chrysalids have shiny spots. The forewings have the submedial vein (vein 1) unbranched and in one subfamily forked near the base; the medial vein has three branches, veins 2, 3, and 4; veins 5 and 6 arise from the points of junction of the discocellulars; the subcostal vein and its continuation beyond the apex of cell, vein 7, has never more than four branches, veins 8–11; 8 and 9 always arise from vein 7, 10, and 11 sometimes from vein 7 but more often free, i.e., given off by the subcostal vein before apex of the cell (Bingham, 1905). The hind wings have internal (1a) and precostal veins. The cell in both wings is closed or open, often closed in the fore, open in the hind wing. The dorsal margin of the hind wing is channelled to receive the abdomen in many of the forms (Bingham, 1905). The antennae always have two grooves on the underside; the club is variable in shape. Throughout the family, the front pair of legs in the male, and with three exceptions (*Libythea*, *Pseudergolis*, and *Calinaga*) in the female also, is reduced in size and functionally impotent; in some, the atrophy of the forelegs is considerable, e.g., the Danainae and Satyrinae. In many of the forms of these subfamilies, the forelegs are kept pressed against the underside of the thorax, and are in the male often very inconspicuous (Bingham, 1905).

The butterfly family Nymphalidae has been an important taxon for developing some of the mentioned hypotheses. Nymphalidae contains around 6000 species. Several members of nymphalidae are considered model organisms in evolutionary biology (Joron, *et al*, 2006; Willmott, et al, 2006; Brakefield, *et al*, 2009). The family most likely originated around 94 MYA in the mid Cretaceous. Diversification of the group began in the Late Cretaceous and most major radiations (current subfamilies) appeared shortly after

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the Cretaceous-Paleogene (K-Pg) boundary (Heikkil, *et al*, 2012). Several attempts have used time-calibrated phylogenies and diversification models to reconstruct the evolutionary history of the group to identify patterns of accelerated or decelerated diversification of some Nymphalidae clades (Heikkil, *et al*, 2012; Elias, *et al*, 2009; Fordyce, *et al*, 2010; Wahlberg, *et al*, 2009). For example, Pena and Wahlberg (2008) suggested that climate change in the Oligocene and the subsequent diversification of grasses has led to diversification of the subfamily Satyrinae (Pena and Wahlberg, 2008) due to the abundance of grasses over extensive geographic areas ("resource abundance-dependent diversity dynamics" hypothesis): Fordyce (2010) found increased net diversification rates in some Nymphalidae lineages after a major host plant shift, which appears to be in agreement with the "escape-and-radiate" model of diversification (Ehrlich and Raven, 1964). Although it has been suggested that part of the great diversity of Nymphalidae butterflies is a result of hostplant-insect dynamics, it is necessary to use modern techniques to investigate whether the diversification patterns of Nymphalidae are in agreement with the theoretical predictions. It is necessary to test whether the overall diversification pattern of Nymphalidae is congruent with events of sudden diversification bursts due to hostplant shift or climatic events (Nylin, *et al*, 2014; Ferrer-Paris, *et al*, 2013). In the study, Pena and Espeland (2015) used a time-calibrated genus-level phylogenetic hypothesis for Nymphalidae butterflies (Wahlberg, *et al*, 2009) to investigate patterns of diversification. Pena and Espeland (2015) applied the statistical method MEDUSA (Malware detection using statistical analysis) of system (Alfaro, *et al*, 2009), to study the diversification pattern of Nymphalidae butterflies. MEDUSA fits likelihood models of diversification into a time-calibrated tree and tests whether allowing increases or decrease the speciation and extinction rates within the tree produces better fit of the models. MEDUSA is able to take into account unsampled extant species diversity during model fitting and it is normally applied to the maximum clade credibility phylogenetic tree. Particularly, Pena and Espeland (2015) wanted to study the effects of phylogenetic uncertainty and by using the extended MEDUSA method called MultiMEDUSA (Alfaro, *et al*, 2009). Pena and Esplanade (2015) also tested whether hostplant association dynamics can explain the diversification patterns of component Nymphalidae lineages by testing whether character states of host plant use affected the diversification pattern of those lineages employing the binary speciation and extinction model (BiSSE) as implemented in the R package diversitree (Fitz John, 2012).

Butterfly Migration

Biological migration is the relatively long-distance movement of individual animals, usually on a seasonal basis. It is the most common form of migration in ecology. It is found in all major animal groups, including birds, mammals, fish, reptiles, amphibians, insects, and crustaceans (*Dingle, et al, 2007).* To be counted as a true migration, and not just a local dispersal or irruption, the movement of the animals should be an annual or seasonal occurrence, such as Northern Hemisphere birds migrating south for the winter; wildebeest migrating annually for seasonal grazing; or a major habitat change as part of their life, such as young Atlantic salmon or Sea lamprey leaving the river of their birth when they have reached a few inches in size (Silva, *et al*, 2013). It's possible to find a few butterfly species straying into city parks and gardens, investigating weedy areas of wasteland or flying in other 'unnatural' habitats, but despite such apparently cosmopolitan lifestyles butterflies are extremely choosy about where they lay their eggs. Butterflies have strict requirements in terms of minimum / maximum temperature tolerance. The habitats they occupy are determined by where their larval food plants grow, and by the availability of

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adult food sources and roosting sites. They are unable to survive and breed unless these and numerous other vital conditions are precisely met. Suitable habitats are often highly localised so consequently many species have an extremely patchy distribution. Most species never stray more than a kilometre away from their established breeding grounds - it would be wasteful of their short lives to ramble across barren habitats where there were no suitable plants on which to lay their eggs. Nevertheless, all species whether humans or butterflies are to a greater or lesser extent genetically programmed to 'leave home', dispersing to explore new areas. It is important to understand the difference between dispersal and migration. The term dispersal is used to describe random and aimless movement away from the site where a butterfly emerges. Dispersing butterflies are easily diverted from their course by minor changes in wind direction or obstacles in their path. They will for example fly around the edge of a block of forest rather than fly through it or over it. When they encounter hostile habitats such as arable farmland, lakes, rivers, roads or buildings they steer left or right to try to find a route around them.

The butterfly migration refers specifically to medium or long distance directional movements by the butterflies. Migrating butterflies have a strong purposeful flight and are unaffected by obstacles or hostile landscapes. If for example they encounter a building they will fly over it rather than take an easier route around it. Their flight path is not affected by wind. The contribution of Carrington Bonsor Williams (7 October 1889 – 12 July 1981) in butterfly migration is well accredited. This name is particularly associated with insect migration, statistical ecology and biogeography. He made uncountable observations himself during his years in the Tropics and he had colleagues all over the world making new observations. He analyzed and published the results in a long series of publications and became a world-leading authority on the subject. Through his research, he was able to shed light on many of the problems, which he had first formulated in his 1930 thesis. He published a much enhanced account on the subject in 1958 (*Wigglsworth, 1982).* He analysed 470 migrations in well-known colorful butterfly, painted lady, *Vanessa cardui* (L) (Family: Nymphalidae) migrations in various parts of the world and found no correlation between flight direction and wind direction. Other studies involving migrations of *Catopsilia florella* and *Eurema hecabe* in Africa, *Pieris brassicae* in England and *Ascia monuste* in North America have arrived at the same conclusion. Migrations usually involve mass movements - a flight of *Vanessa cardui* in California in 1924 was estimated to contain about 3000 million butterflies. It has been estimated that a swarm of migrating snout butterfly, *Libytheana carinenta* (L) in Texas in 1921 was passing at a rate of over a million butterflies per minute across a 250-mile-wide front. Migrations often begin spontaneously across a wide area, but once in the air the insects all head towards a common destination. It is generally accepted that migration is a 2-way process e.g. butterflies migrating south in autumn will return north again in the spring. In some cases, an individual butterfly will take part in both legs of the journey, but in many species a 'parent' generation flies in one direction, and it is the offspring that undertake the return journey. The migrant species such as *Danaus plexippus, Vanessa cardui* or *Pieris brassicae* would have an extremely directional flight pattern and would fly over a hostile habitat to maintain its compass direction.

Random dispersal in Butterflies:

Nothing in nature is constant. Habitats are continually changing. Woodlands become overgrown and shade out herbaceous plants on which the caterpillars of many butterflies depend. Heathlands catch fire, grasslands become overgrown with scrub, deserts expand, cliffs crumble away. Species at the edge of

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their natural distribution range tend to inhabit sites which are sheltered from bad weather. Pearl-bordered Fritillaries for example occupy open meadows in mainland Europe, but in Britain such habitats are too cold for them so they form colonies in sheltered woodland clearings instead. Unfortunately, these habitats are ephemeral. They fast become overgrown and the violets on which the Fritillary caterpillars feed rapidly get shaded out. Within 2-3 years the habitat can no longer support the species, so the adult butterflies disperse soon after mating, radiating out along forest trails in search of more suitable breeding areas. Many other factors can trigger dispersion e.g. after a particularly successful breeding season Marsh Fritillary *Euphydryas aurinia* populations can reach explosive levels. The larvae scour their habitat, devouring every available leaf of their food plant. Ultimately they sense imminent starvation, and undergo a chemical change which switches them into a high activity phase causing them to swarm across the surrounding countryside in search of food.

Daily Commuting in Buterflies:

In Britain adults of *Clossiana euphrosyne* nectar almost exclusively on bugle - *Ajuga reptans*. They lay their eggs on dead bracken or dry grass stems, but their caterpillars feed on Viola. Fortunately for the butterfly all of these plants can be found in the same habitat - recently cleared woodland, so it is here that the butterflies spend their entire lives. Many other species however are not so lucky - their larval food plants may grow in entirely different places from the adult food sources, so they need to commute between breeding and feeding sites. Species such as *Apatura iris* which occur at low density in woodland habitats can't easily locate the opposite sex, so they have evolved 'hill-topping' - a strategy whereby both sexes fly to the highest point in the vicinity, typically a tall oak tree on a ridge, where courtship and copulation take place. After mating the females disperse to lay their eggs on sallow bushes which typically grow alongside ditches on lower ground. The males also disperse to low lying areas where they feed by imbibing mineralised moisture from the paths or patches of mud. Next morning, they commute back to the 'master' oak tree to mate with other females. Purple Emperor *Apatura iris* commutes daily between feeding and courtship sites.

Montane butterflies:

In temperate regions mountainous areas such as the Alps, Pyrenees, Rockies and Tien Shan, land above about 1800m is covered in snow for much of the year. In the Andes, the Himalaya and the mountain ranges of New Guinea areas as low as 3000m are subject to seasonal snow cover. During the short montane summer however, the meadows and pastures become carpeted in vast swathes of flowers, attended by hordes of butterflies. Swarms of Blues, Fritillaries and Skippers aggregate to imbibe moisture from patches of mud; while Coppers, Ringlets, Apollos and Heaths nectar avidly at the abundant flowers. Most of these species are sedentary insects, forming highly localised breeding colonies. Because they are 'stay-at-home' species, their flight season is limited to 2-3 weeks in mid-summer, and they have to spend several months of their lives hibernating as either eggs or caterpillars. Other species such as Clouded Yellows, Whites and Swallowtails are nomadic, and migrate down to the lowlands in late summer to breed. In the early spring their progeny produces a further brood in the lowlands, but the habitat there becomes too hot and dry in summer, so they then return to the mountainsides where there is cooler air and an abundance of flowers for nectaring. Another form of altitudinal movement takes place on a daily basis. In alpine regions one side of a mountain may remain in the shade until late morning. Sunlight

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reaches the east facing slopes first, but may not reach steep west facing slopes until late afternoon. Consequently, butterflies commute around the mountainsides to keep pace with the sun. Butterflies commute altitudinally too, moving from peaks to valleys and back again, to areas where the temperature is most suitable. Sometimes these journeys take them to mountain passes. Over the millennia these become established routes by which species migrate seasonally from one valley to another.

Seasonal Butterfly Migration

Seasonal migration is an entirely different phenomenon from commuting or random dispersal. It tends to occur spontaneously and involves the mass movement of hundreds, thousands or even millions of butterflies. Long-distance migration can lower parasite prevalence if strenuous journeys remove infected animals from wild populations. The authors of this study examined wild monarch butterflies to investigate the potential impact of the protozoan parasite *Ophryocystis elektroscirrha* on migratory success. The researchers collected monarchs from two wintering sites in central Mexico to compare infection status with hydrogen isotope measurements, an indicator of latitude of origin at the start of fall migration.

On average, uninfected monarchs had lower hydrogen isotope values than parasitized butterflies, indicating that uninfected butterflies originated from more northerly latitudes and travelled farther distances to reach Mexico. Within the infected butterflies, monarchs with higher levels of infection originated from more southerly latitudes, indicating that heavily infected monarchs originating from farther north were less likely to reach Mexico. The authors used observations of infection levels during the breeding season to show that southerly latitudes did not simply generate more infected monarchs prior to the start of the migration.

Collectively, these results emphasize that seasonal migrations may help lower infection levels in wild animal populations. The authors posit that these results combined with recent observations of sedentary, winter-breeding monarch populations in the southern U.S. indicate that the shifts from migratory to sedentary behavior may lead to greater infection for North American monarchs.

The chemical markers allowed us to estimate where the monarchs started and how far they travelled to reach the wintering sites in Mexico, something that would not be possible using other currently available methods. It is also found that monarchs with larger wings migrated farther distances on average than those with smaller wings, something that's supported by cross-population comparisons but hasn't been previously shown within North American migratory monarchs.

The Evolution of Migratory Behaviour in Butterflies:

When butterflies first evolved the present day continents were united to form the giant land mass Pangaea. In the centre of such a massive continent there would have been huge seasonal extremes of temperature and humidity. Consequently, butterflies would have had to find some way to survive when their larval food plants and nectar sources wilted in summer, or when temperatures were too high or too low for normal activity. One choice would be to remain in situ and diapause, i.e. to aestivate. In a diapaused state large numbers would perish due to predation by insectivorous birds. A better alternative would be to fly to another location e.g. close to a river, where food plants would continue to be available long after the surrounding land had dried out. Further food plants would then be found by migrating up or down river. Natural selection would ensure that butterflies which survived as a result of such migratory actions would be able to pass on the trait genetically. It is perhaps no coincidence that so many species in

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the tropics still use rivers and streams as migration paths. In subsequent geological periods the migratory behaviour would have been interrupted as tectonic activity caused mountain ranges and seas to appear, thereby splitting up formerly contiguous areas of breeding terrain. These geological movements took place over millions of years, during which butterflies probably continued to migrate along the same routes, crossing mountain ranges via low passes, and hopping from island to island to cross seas and oceans. Many species would have been unable to overcome the new natural barriers, particularly the ever widening oceans. Their populations therefore became permanently divided, gradually taking on new characteristics, and ultimately evolving into new species. Other species however managed to cross the barriers regularly, and migratory behaviour became genetically imprinted in them.

Triggers of Butterfly Migration:

Individual migrations appear to be triggered primarily by climatic phenomena, often in association with over-abundance, and depletion of larval food resources. C. B. Williams in his book 'Insect Migration' quotes Skertchley, who in March 1869 witnessed the commencement of a migration of Vanessa cardui in desert behind Suakin by the Red Sea: "He noticed that the whole mass of grass, through which they were riding on camels, was in a state of violent agitation although there was no wind. When he dismounted he found that the cause was the emergence from the chrysalis of myriads of Painted Lady butterflies, which dried their wings and about half an hour later flew off together eastwards towards the sea". Often climatic differences on opposite sides of a mountain range will cause butterflies to migrate between them, ascending to cross over high alpine passes. Beebe's observations include accounts of over 250 butterfly species migrating through the 1000m high Portacheulo Pass in Venezuela. 22 of these species were said to have occurred in "thousands". In late May 1946 he and 4 colleagues used stop watches and counters to try to estimate the numbers of *Eunica monima* migrating through the pass. In Beebe's own words they "completely failed to keep up with fast enough estimates of numbers, but at a minimum clocked 1000 per second going past in the face of a gentle breeze".

Route-Finding in Butterfly Migration:

The studies on Monarchs has shown that their annual migration from Canada to Mexico is controlled by a 'time-compensated sun compass' that depends on light receptors, and a circadian clock built into the antennae. When scientists removed the antennae from one group of Monarchs they flew strongly but in random directions, but a control group with their antennae intact all flew in the same direction - their south-westerly migration route. In another experiment the antennae of some were painted with black enamel, and these butterflies when placed in a flight simulator all flew together, but in the 'wrong' direction compared to their normal migration route. Another group had their antennae painted with transparent paint, and these all migrated together in the right direction. Research by Chapman suggests that migratory butterflies and other insects are programmed to seek out 'wind highways' in the sky, which they use to enable them to travel quickly during their migratory flights. This may be the case with certain species, but it is well documented that species including Colias crocea, Vanessa cardui and Pieris rapae fly very low over the sea when migrating from the European mainland to Britain. There is for example a famous account by Rev. Harrison, who in 1868, from a cliff near Marazion, Cornwall, observed "a yellow patch out at sea, which as it came nearer showed itself to be composed of thousands of Clouded Yellows, which approached flying close over the water, rising and falling over every wave till they

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reached the cliffs". A team of neurobiologists led by Steven Reppert of the University of Massachusetts spent several years investigating Monarchs. In 2010 they published a paper indicating that they had discovered that Monarchs have 2 types of photoreceptor proteins which not only allow them to see UV light but also enable them to detect the Earth's magnetic field. A series of experiments on Drosophila fruit flies whose genomes were engineered using Monarch Cry1 and Cry2 cryptochrome proteins proved that they respond to magnetic fields when under the influence of UV-A/blue light.

Expansion and Contraction of Range of Butterfly Migration:

The range is nothing but the overall area in which a species can be found. Within that range there will be areas of unsuitable habitat so the distribution within a butterfly's range is always patchy. The range and distribution are limited by climate, geology, aspect and altitude, all of which affect the type of larval food plants and adult nectar sources that will grow in an area. The distribution of a species within its range is also greatly affected by human intervention - urban expansion has the greatest impact, but governmental policy on farming, forestry and road planning also has a very profound effect on the distribution and abundance of butterflies. The best example is the High Brown Fritillary *Argynnis adippe* which was widely distributed and common in England until the 1950's. It's range then contracted rapidly as a result of habitat fragmentation, and a change from traditional coppice woodland management to the mass planting of conifers in English forests. By the turn of the 21st century the butterfly had disappeared from virtually all of its former habitats. Now in 2012 it clings to its existence at just a handful of sites in western England. Most other forest butterflies have also declined as a result of being shaded out of the darker and cooler modern woodlands. Only one British species *Pararge aegeria* has benefited, as it survives better in shadier conditions. It has even been able to increase its formerly patchy distribution in the UK to the point where it is currently widespread and common over almost its entire range.

Monarh Migration: The Example of Butterfly Migration:

The most recognized butterflies of North America are the Monarch butterflies (Danaus *plexippus* L.) These milkweed varieties of butterflies come from the family of Danainae, a subfamily of Nymphalidae. People have seen this species in Australia and New Zealand since 1871, where they call it "the wanderer." It inhabits the Azores, Canary Islands and Madeira. Occasionally you can sight them in Western Europe and rarely in the United Kingdom. You can easily identify these beautiful butterflies by their wings with black and orange pattern, and a wingspan of 3½–4 in or 8.9–10.2 cm. Males are a bit bigger than female monarchs are and have a spot known as the androconium in the middle of each rear wing. Wings of female's boast of darker veins. Monarchs are among a small group of butterflies, mostly related species that make a two-way migration in one generation. And, of this unique few, the fall migration of monarchs from Canada and the United States to overwintering sites in Mexico is both the longest known and most spectacular. How the monarch is able to accomplish this amazing feat is the subject of much speculation and research. Scientists are getting closer to understanding how monarchs sense changing environmental signals in both fall and spring and how they modify their behavior based on these changes to get to their destinations. When monarchs take off for the south bound leg of their journey, people might see many hundred, even a thousand, in well-known viewing places like Point Pelee in Southern Ontario, Canada. Several migration routes in central southern Canada lead down through the central U.S. Most monarchs that migrate to Mexico originate from the northern breeding grounds east of the Rocky Mountains and

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north of the central United States (e.g. Oklahoma). A smaller monarch population that breeds in areas west of the Rockies overwinters at numerous sites scattered along the California coastline from San Francisco to San Diego. Getting to Mexico isn't easy. It's not just a matter of flying south. If they only flew south, monarchs would end up in the Gulf of Mexico. Rather to get to Mexico, they set a course, and this course is different for different regions of the country. Monarchs passing through Washington, D.C. are moving west-southwest, near Atlanta the direction is almost due west, and in Lawrence, Kansas about south-southwest. How monarchs set these courses is unknown. Do they use celestial cues or magnetic information, some combination of the two or are other factors involved? Scientists are working to solve this puzzle. We do know that they use a combination of biological clocks, one set in the antennae and another in the brain that are used to stay on course. Surviving the trip to Mexico involves elements of luck as well as specific adaptations that improve the odds of reaching the overwintering sites. The butterflies must avoid everything from vehicles to pesticides, spider webs, storms and the occasional bird that has yet to learn that monarchs aren't to be eaten due to their distasteful chemistry. In addition to their unique ability to set a course that will take them to the right place, monarchs have flight adaptations that improve the chances of arriving at the overwintering sites in good condition. Rather than using powered flight – that is, constant flapping –monarchs use gliding and soaring to advance to the southwest. As the Sun heats the ground, thermals form. As monarchs encounter these warm rising air masses, they set their wings like hawks and spiral upward on the rising air. Once they reach the top of the thermal, they begin to glide. The glide ratio is about 3.5 to 1, meaning that for every 3.5 feet forward they loose about a foot in altitude. By flapping their wings 2-3 times every 20-30 feet, they can extend the glide until they reach another thermal. Thermals frequently carry monarchs to 1,000 feet, and some have been sighted a mile or more above the ground. This behavior conserves energy and saves their muscles and fragile wings. Most monarchs arriving at the overwintering sites are in remarkably good condition despite flights of up to 2,000 miles. As monarchs move across the continent, they encounter relatively flat forests, farmlands and grasslands, as well as mountain ranges and large lakes. They deal with differences in topography in a variety of ways. When they encounter large lakes, if the weather isn't favorable, monarchs may accumulate for days waiting for favorable winds that will aid their passage. In mountainous areas they often ride the thermals that rise along the ridges, frequently taking the same pathways as migrating hawks. In relatively flat areas they move to the southwest in directions that are appropriate for the latitude and longitude in which they find themselves. As the migration progresses, monarchs from as far east as New Brunswick and Maine and as far west as the front range of the Rockies converge on Texas, in effect funneling down to a 50-mile wide gap of cool river valleys between Eagle Pass, Texas, and Del Rio, Texas, their last stops before moving into the mountains of northern Mexico. Once in Mexico, monarchs tend to follow the mountains to the general area of the overwintering sites. Once they reach the overwintering area at the end of October, they begin to cluster on the oyamel fir trees on the ridge tops. With each day, as more monarchs arrive through November, the clusters in the oyamels become larger while moving toward more protected sites below the ridges. Distinct clusters are called colonies and some of these colonies can cover many acres with up to 25 million butterflies per acre. These colonies persist from November to March with some monarchs beginning to move northward by the end of February. The "Flight of the Butterflies" is about Dr. Fred Urquhart's quest to discover where and how monarchs overwintered. It is likely that what he found exceeded his expectations. In the film, he is seen with his map, filled with known monarch migration paths. These lines represent paths that are known to contain

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thousands of butterflies, where there were numerous monarch sightings. Two frequently asked questions about monarchs are "Why migrate?" and "Why migrate to these specific sites in Mexico?" Monarchs are not winter-hardy. Their resistance to freezing is minimal. To survive from one season to the next, they migrate to oyamel fir forests above 10,500 feet, a cool habitat where the daytime temperatures seldom exceed 65°F and the nighttime lows are seldom below freezing. The forest is a blanket that protects the monarchs. Monarchs remain relatively inactive through the winter, surviving by converting fats stored in the fall to blood sugars necessary to keep their bodies functioning. The monarch colonies are located in a relatively small area at 19.5 north latitude, but why this latitude (and longitude), and why these same locations in the forest each year to form colonies? Scientists don't have answers to these questions –but there is no lack of speculation and interest. The beauty of monarch butterfly lies in it's strict follow up in the flight schedule. A migratory monarch probably maintain a modest flight schedule, flying three to five 5 hours and advancing 30-50 miles to the SW when weather conditions favour flight.

Table- 1: Flight Schedule of monarch butterfly, *Danaus plexippus plexippus* (L).

Day Time	Monarch Schedule
9:00 a.m. – 9:45 a.m.	Sun bath. Warmed by the Sun hitting the overnight roost site
9:00 a.m. – 9:45 a.m.	Visit to flower for nectar
10:00 a.m. – 4.30 p.m.	The migratory flight. Stopping periodically for 10-15 minute feeding episodes
4:30 p.m. – 5:00 p.m.	Stops migratory flight and feeds for at least 30 minutes on flower nectar.
5:00 p.m. – 5:30 p.m.	Searches for overnight roosting site, preferably one that is well sheltered with many other monarchs
5:00 p.m. – 6:00 p.m.	Settles on roost for the remainder of the night, converts sugars from last nectar feeding to fats and blood sugar needed for the next day's flight
6:30 p.m. – 9:00 a.m. (Next Morning)	Sleep

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Fig.1: Adult Monarch butterfly, *Danaus plexippus* (L).

This scenario is based on the flight of a late season monarch that averaged 61 miles per day from North Carolina to Austin, Texas, and probably required close to sixhours of flight per day. Monarchs average about 11mph with powered flight –slower when gliding and soaring. The Monarch butterfly migrates for 2 reasons. They can not withstand freezing weather in the northern and central continental climates in the winter. Also, the larval food plants do not grow in their winter overwintering sites, so the spring generation must fly back north to places where the plants are plentiful.

Nymphalidae Butterfly Diversity of Mayureshwar Wildlife Sanctuary of Baramati Tehsil in Pune district (India):

The Nymphalidae is a family of several thousand species found in all zoogeographical regions of the world. Most are medium or large in size, but the family is highly variable given that it also includes the *Satyrinae*, a subfamily that has been designated as a family in its own right in earlier classifications. The forelegs in both sexes are vestigial and useless for walking. In the male, there are typically only 2 tarsal joints and the legs have a brush-like appearance, resulting in a common name for this family - the "brush-footed butterflies". The female foreleg has 4 tarsal joints which, when compared with the male, provides a mechanism of determining the sex of the adult. The midleg and hindleg are normal in both sexes and both tibia and tarsus may have spines. Butterflies of Family: Nymphalidae recorded at Mayureshwar Wildlife Sanctuary of Baramati Tehsil Dist. Pune (India) are listed in table-2 and Fig.2.

Table 2. Butterflies of Family: Nymphalidae recorded at Mayureshwar Wildlife Sanctuary of Baramati Tehsil Dist. Pune (India).

Serial No.	Common Name	Scientific Name	Food Plants preferred by Larval Stages	Relative Abundance
1.	Dark Blue Tiger	*Tirumala septentrionis* Butler.	*Ageratum conyzoides*,	Uncommon

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			Vallaris spp.	
2.	Plain Tiger	*Danaus chrysippus* L.	*Frerea* spp., *Calotropis* sp.	Very Common
3.	Striped Tiger	*Danaus genutia* Cramer.		Uncommon
4.	Glassy Tiger	*Parantica aglea* Stoll.	*Calotropis* sp.	
5.	Chocolate Tiger	*Parantica melaneus* Cramer.		Rare
6.	Striped Blue Crow	*Euploea mulciber* Cramer.	*Ficus* sp.	Uncommon
7.	Common Crow	*Euploea core* Cramer.	*Ficus* sp., *Nerium* sp.	Common
8.	Common Duffer	*Discophora sondaica* Boisduval.	*Dendrocalamus* sp.	Common
9.	Common Evening Brown	*Melanitis leda* L.	*Panicum* spp., *Sorghum* spp.	Very Common
10.	Dark Evening Brown	*Melanitis phedima* Cramer.		Rare
11.	Common palmfly	*Elymnias hypermnestra* L.	*Calamus* spp., *Areca* spp.	Very Common
12.	Common Bushbrown	*Mycalesis perseus* Fabricius.	Grasses	Very Common
13.	Dark-Brand Bushbrown	*Mycalesis mineus* L.	Grasses	Common
14.	Common Fourring	*Ypthima huebneri* Kirby.	Grasses	Common
15.	Common Fivering	*Ypthima baldus* Fabricius.		Common
16.	Vagrant	*Vagrans egista* Cramer.		Uncommon
17.	Common Leopard	*Phalanta phalantha* Drury.	*Flacourtia* spp.	Very Common
18.	Commander	*Moduza procris* Cramer.	*Mussaenda frondosa*	Uncommon
19.	Common Sergeant	*Athyma perius* L.	*Glochidion* sp.	Common
20.	Colour Sergeant	*Athyma nefte* Cramer.	*Glochidion* sp.	Uncommon
21.	Common Lascar	*Pantoporia hordonia* Stoll.	*Acacia* spp.	Uncommon

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22.	Common Sailer	*Neptis hylas* L.	*Bombax* sp.	Very Common
23.	Short-Banded Sailer	*Phaedyma columella* Cramer.	*Dalbergia* sp.	Uncommon
24.	Clipper	*Parthenos sylvia* Cramer.		Very Rare
25.	Common Baron	*Euthalia aconthea* Cramer.	*Mangifera indica* L.	Uncommon
26.	Plain Earl	*Tanaecia jahnu* Moore.		Rare
27.	Archduke	*Lexias pardalis* Moore.	*Garcinia* sp.	Very Rare
28.	Common Castor	*Ariadne merione* Cramer.	*Ricinus communis*	Common
29.	Grey Pansy	*Junonia atlites* L.	*Barleria* sp.	Very Common
30.	Peacock Pansy	*Junonia almanac* L.	*Barleria* sp.	Very Common
31.	Yellow Pansy	*Junonia hierta* Fabricius.	*Barleria* sp.	Very Common
32.	Lemon Pansy	*Junonia lemonias* L.	*Barleria* sp.	Common
33.	Chocolate Pansy	*Junonia iphita* Cramer.		Uncommon
34.	Great Eggfly	*Hypolimnas bolina* L.	*Hibiscus* sp.	Common

Fig. / Plate – 2 : Butterflies of Family: Nymphalidae recorded at Mayureshwar Wildlife Sanctuary of Baramati Tehsil Dist. Pune (India).

Dark Blue Tiger, *Tirumala septentrionis* Butler.

Plain Tiger, *Danaus chrysippus* L.

Striped Tiger, *Danaus genutia* Cramer.

Glassy Tiger, *Parantica aglea* Stoll.

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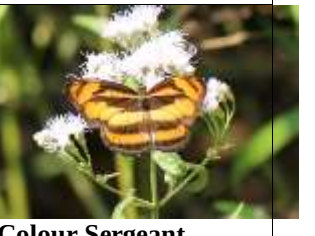
 **Chocolate Tiger, *Parantica melaneus* Cramer.**	 **Striped Blue Crow, *Euploea mulciber* Cramer.**	 **Common Crow, *Euploea core* Cramer.**	 **Common Duffer, *Discophora sondaica* Boisduval.**
 **Common Evening Brown, *Melanitis leda* L.**	 **Dark Evening Brown, *Melanitis phedima* Cramer.**	 **Common palmfly, *Elymnias hypermnestra* L.**	
 **Dark-Brand Bushbrown, *Mycalesis mineus* L.**	 **Common Fourring, *Ypthima huebneri* Kirby.**	 **Common Fivering, *Ypthima baldus* Fabricius.**	 **Vagrant, *Vagrans egista* Cramer.**
 **Common Leopard, *Phalanta phalantha* Drury.**	 **Commander, *Moduza procris* Cramer.**	 **Common Sergeant, *Athyma perius* L.**	 **Colour Sergeant, *Athyma nefte* Cramer.**

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 **Common Lascar, *Pantoporia hordonia* Stoll.**	 **Common Sailer, *Neptis hylas* L.**	 **Short-Banded Sailer, *Phaedyma columella* Cramer.**	 **Clipper, *Parthenos sylvia* Cramer.**
 **Common Baron, *Euthalia aconthea* Cramer.**	 **Plain Earl, *Tanaecia jahnu* Moore.**	 **Archduke, *Lexias pardalis* Moore.**	 **Common Castor butterfly, *Ariadne merione* L.**
 **Grey Pansy, *Junonia atlites* L.**	 **Peacock Pansy, *Junonia almanac* L.**	 **Yellow Pansy, *Junonia hierta* Fabricius.**	 **Lemon Pansy, *Junonia lemonias* L.**

This is a large and diverse family that includes the typical Nymphalinae (brush-footed butterflies, admirals, checkerspots), Libytheinae (snout butterflies), Satyrinae (wood nymphs, ringlets), Heliconiinae (long wings, fritillaries), Morphinae (morpho and owl butterflies), and Danainae (milkweed and glasswing butterflies). All possess three longitudinal ridges (carinae) on the ventral surface of the antennae that are unique in Lepidoptera, and the forelegs of males are reduced or modified (less so in Libytheinae), usually lacking claws and nonfunctional for walking. Adults are small to very large (FW usually 10–50 mm, ranging to 75 mm in tropical *Morpho* and *Caligo*), mostly broad winged except in Heliconinae, and usually brightly colored, often with orange, black, and white dominating, but mostly brown and tan in Satyrinae. Many tropical nymphalids are involved in mimicry complexes, either as models (Danainae, Heliconiinae) or as mimics of them or other distasteful butterflies and moths and/or they benefit in both roles. Glasswing butterflies (Ithomiini) live primarily in deep shade of tropical forests and have sparsely scaled areas or transparent wings, with subtle color patterns, while owl butterflies fly at

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dusk. They, morphos, and satyrines have conspicuous eyelike spots near the margins of the wing undersides, presumably confusing would-be predators or diverting their attacks from the body. The larvae are cylindrical caterpillars with full complement of abdominal prolegs, but there are diverse modifications, e.g., densely spinose or with dorsal projections (verrucae) that are spinose (Nymphalinae), smooth with filaments (Danainae), smooth with bifid caudal segment (Satyrinae), pubescent with hair tufts and usually bifid caudally (Morphinae). The pupa hangs head downward, attached by a cremaster, without a silken girdle. The larvae feed on a diverse array of flowering plants, with considerable specialization within subfamilies: Morphinae and Satyrinae almost exclusively on monocots, including Arecaceae, Bromeliadaceae, Helioconiacae, and Musaceae (a few species are pests on bananas) in the tropics, mostly Poaceae and Cyperaceae in the Holarctic, with 2 genera on Selaginellaceae; other nymphalids eat mostly dicot angiosperms, often specializing on plants with toxic chemicals (e.g., Heliconiinae on Flacourtiaceae, Passifloraceae, Urticaceae, Violaceae) or latex-producing plants (Danainae on Apocynaceae, Asclepiadaceae, Moraceae).

Keith Brown suggested that feeding on Solanaceae was an important event in the diversification of Ithomiini butterflies (Brown, 1987). Ithomiini butterflies are exclusively Neotropical and most species feed on Solanaceae hostplants during larval stage (Willmott and Freitas, 2006). Optimizations of the evolution of hostplant use on phylogenies evidence a probable shift from Apocynaceae to Solanaceae in the ancestor of the tribe (Willmott and Freitas, 2006; Brower, *et al*, 2006). Fordyce (2010) found that the Gamma statistics, a LTT plot of an Ithomiini phylogeny and the fit of the density-dependent model of diversification are consistent with a burst of diversification in Ithomiini following the shift from Apocynaceae to Solanaceae.

The present attempt on butterflies of Family: Lymphalidae recorded at Mayureshwar Wildlife Sanctuary of Baramati Tehsil Dist. Pune (India) investigated whether the strong signal for an increase in net diversification rate for Ithomiini (found by MEDUSA) can be explained due to the use of Solanaceae plants as hosts during larval stage. For this, we used a Bayesian approach (FitzJohn, *et al*, 2009) to test whether the trait "feeding on Solanaceae" had any effect on the diversification of the group. The BiSSE analysis through the attempt on butterflies of Family: Lymphalidae recorded at Mayureshwar Wildlife Sanctuary of Baramati Tehsil Dist. Pune (India) extended to take into account missing taxa and phylogenetic uncertainty, shows a significantly higher net diversification rate for Ithomiini taxa, which can be attributed to the trait "feeding on Solanaceae host plants". This result is in agreement with previous findings using other statistical methods (Fordyce, 2010). Due to the fact that Ithomiini are virtually the only nymphalids using Solanaceae as host plants, it is possible that the trait responsible for a higher diversification of Ithomiini might not be the host plant character. As noted by Maddison *et al*. (2007), the responsible trait might be a co-distributed character such as a trait related to the ability to digest secondary metabolites. Solanaceae plants contain chemical compounds and it has been suggested that the high diversity of Ithomiini is consistent with the "escape-and-radiate scenario" due to a shift onto Solanaceae (Fordyce, 2010) and radiation scenarios among chemically different lineages of Solanaceae plants (Fordyce, 2010; Brown, 1987). According to this theory, the shift from Apocynaceae to Solanaceae allowed Ithomiini to invade newly available resources due to a possible key innovation that allowed them cope with secondary metabolites of the new hosts. Additional studies are needed to identify the actual enzymes that Ithomiini species might be using for detoxification of ingested food as they have been found in other butterfly groups (Wheat, *et al*, 2007). The increase in diversification rate inferred by MEDUSA

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occurred after the probable shift from Apocynaceae to Solanaceae, as the Solanaceae feeders in the sub-tribes Melinaeina and Mechanitina are not included in the diversification shift. The apparent conflicting results from MEDUSA and BiSSE can be explained by the low species-richness of the subtribes Melinaeina and Mechanitina compared to the other subtribes included in the shift (fifty-two versus two hundred seventy-two species). It can be that MEDUSA is more conservative than BiSSE and is not including Melinaeina and Mechanitina in the shift due to low species numbers. Although the Solanaceae genera used by the Ithomiini clades are well known (Willmott and Freitas, 2006), the present attempt does not have any understanding on the physiological routes involved in the detoxification of Solanaceae compounds by the several lineages of Ithomiini. The present attempt can speculate that older lineages exploiting a novel toxic resource (Willmott and Freitas, 2006; Wahlberg, *et al*, 2009) may be inefficient in metabolizing plant toxins and that younger lineages are able to deal with toxins more efficiently, so that host switching events within Solanaceae are possible, which can lead to higher diversification. Studies in *Papilio* species have reported that detoxification enzymes can become more efficient in metabolizing toxins than ancestral configurations of the proteins, providing more opportunities for hostplant switches (Li, *et al*, 2009). This might be the reason why the basal Ithomiini subtribes Melinaeina and Mechanitina are so species-poor and restricted to few Solanaceae hosts (Willmott and Freitas, 2006), while recent subtribes are species-rich and have expanded their host range into several Solanaceae lineages (Willmott and Freitas, 2006). It might be that the switch to feeding in Solanaceae was an important event in the evolutionary history of Ithomiini, but the actual radiation occurred after critical physiological changes (a probable key innovation) allowed efficient detoxification of Solanaceae toxins.

The hypothesis entitled, "Diffuse Co-speciation" predicts almost identical ages of insects and their host plants. The hypothesis entitled, "Resource Abundance-Dependent Diversity" and the hypothesis entitled, "Escape-And-Radiate" postulate that, insects diversify after their host plants (Nyman, *et al*, 2012; Ehrlich and Raven, 1964). Wheat *et al*. (2007) found strong evidence for a model of speciation congruent with Ehrlich and Raven's hypothesis in Pieridae butterflies due to, in addition to the identification of a key innovation, a burst of diversification in glucosinolate-feeding taxa shortly afterwards (with a lag of circa 10 MY). According to a recent dated phylogeny of the Angiosperms (Bell, *et al*, 2010), the family Solanaceae split from its sister group about 59 (49–68) MYA and diversification started (crown group age) around 37 (29–47) MYA. Wahlberg *et al*. (2009) give the ages for origin and diversification for Ithomiini at 45 (39–53) and 37 (32–43) MYA, respectively. Thus, current evidence shows that Solanaceae and Ithomiini might have diversified around the same time, during the Late Eocene and Oligocene, and this would be congruent with the diffuse co-speciation hypothesis.

Butterflies of Danaini Tribe of Nymphalidae

The Danaini are a tribe of brush-footed butterflies (family Nymphalidae). Their type genus *Danaus* contains the well-known monarch butterfly (*D. plexippus*) and is also the type genus of the tribe's subfamily, the milkweed butterflies (Danainae). The Danaini do not have a fixed colloquial name for the entire tribe, but in particular for subtribe Danaina the term tiger butterflies is occasionally used in reference to the numerous species in several genera. MultiMEDUSA approach in present attempt showed a significant slowdown in net diversification rate in the sub-tribe Danaina of the Danini. Both Danaina and the sister clade Euploeina feed mainly on Apocynaceae and thus a host plant shift should not be

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responsible for the observed slowdown of diversification in the Danaina. As expected, BiSSE analysis of Apocynaceae feeders shows that there is no effect of feeding on this plant family on the net diversification rates of Nymphalidae lineages. Many of the Danaina are large, strong fliers, highly migratory and involved in mimicry rings, including the best-known migratory butterfly, the monarch (*Danaus plexippus*). The causes for a lower net diversification rate in the Danaina remains to be investigated, but their great dispersal power might be involved in preventing allopatric speciation. It has been found in highly vagile species in the nymphalid genus *Vanessa* that dispersal has homogenized populations due to gene flow, as vagile species seem to be genetically homogeneous among populations (Wahlberg and Rubinoff, 2011).

Butterflies of Satyrinae Tribe of Nymphalidae

The Satyrinae, the satyrines or satyrids, commonly known as the browns, are a subfamily of the Nymphalidae (brush-footed butterflies). They were formerly considered a distinct family, Satyridae. This group contains nearly half of the known diversity of brush-footed butterflies. The true number of the Satyrinae species is estimated to exceed 2400. They are generally weak fliers and often shun bright sunlight, preferring moist and semishaded habitats. The caterpillars feed chiefly on monocotyledonous plants such as palms, grasses, and bamboos. The Morphinae are sometimes united with this group. The taxonomy and systematics of the subfamily are under heavy revision. Much of the early pioneering work of L. D. Miller (Savela, Markku, 2007) has helped significantly by creating some sort of order. *Dyndirus* (Capronnier, 1874) is a satyrid *incertae sedis*. Other than this genus, according to the latest studies on the classification of Nymphalidae, all satyrines have been assigned to one of the tribes, at least preliminarily (Savela, Markku, 2007). Lineages in the diverse family Satyrinae radiated simultaneously with the radiation of their main hostplant, grasses, during the climatic cooling in the Oligocene (Pena and Wahlberg, 2008). Thus, it is somewhat surprising that part of Satyrinae were found to have accelerated diversification in only 13% of the trees from the posterior distribution. Although this can be attributed to low phylogenetic signal, the clade Satyrini is very robust and MEDUSA failed to identify any significant accelerated net diversification rate for Satyrini (Wahlberg, *et al*, 2009). It appears that the radiation of Satyrini as a whole was not remarkably fast and therefore not detected by MEDUSA, although it estimated a diversification shift for Satyrini + its sister clade. This should be expected if the diversification of Satyrini occurred in a stepwise manner, with pulses or bursts of diversification for certain lineages but unlikely for the tribe Satyrini as a whole.

The present attempt on butterflies of Family: Lymphalidae recorded at Mayureshwar Wildlife Sanctuary of Baramati Tehsil Dist. Pune (India) found that, even though MEDUSA estimated several diversification shifts in the maximum clade credibility tree of Nymphalidae, only a few of these shifts were found in more than 90% of the trees from the posterior distribution. In the literature, it is common practice that conclusions are based on the shifts estimated on the maximum clade credibility tree. However, by using a MultiMEDUSA approach, the attempt found that for this Nymphalidae dataset some of these shifts might be greatly affected by phylogenetic uncertainty. Moreover, some of these shifts can be recovered either as increases or decreases in net diversification rate depending on the tree from the posterior distribution that was used for analysis. The method MEDUSA appears to be sensitive to the number of nodes with high posterior probability and width of age confidence intervals. For data of present attempt, it would be necessary to obtain a posterior distribution of trees with no conflicting topology, and very similar

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estimated ages for nodes in order to consistently recover most of the diversification shifts on the posterior distribution of trees that were inferred by MEDUSA on the MCC tree.

Conclusion

In a nut shell, let us conclude the journey. The family is known as the Brush-Footed butterflies because the forelegs of the adults are small and hairy, resembling tiny brushes, and are not used for walking. At least 150 species of Nymphalids can be found in North America, with 47 occurring in Idaho. These include the Fritillaries (Subfamily Heliconiinae), the true Brush-Foots (Subfamily Nymphalinae), and the Admirals and Relatives (Subfamily Limenitidinae). The butterflies in this family vary considerably in their appearance, but generally can be characterized by the following, in addition to their reduced forelegs:

1. Medium to large in size and brightly and/or uniquely marked.
2. The pattern of wing veins of the forewing is unique.
3. The rigid antennae are tipped with little knobs, called clubs.

Interesting traits demonstrated by some members of this family include lengthy migrations, territoriality, and the ability to overwinter as adults. Eggs vary in shape and in their arrangement on the plant. Caterpillars vary considerably in their appearance, but are often hairy or spiny. Pupae have a cremaster from which they are suspended upside down, but have no silk girdle and form no cocoon. Caterpillars are the typical overwintering stage, although the adults of some species may overwinter as well.

Utility of DNA barcoding may have a excellent dimension of diversity of butterflies in the Indian sanctuaries (like Mayureshwar Wildlife Sanctuary of Baramati Tehsil Dist. Pune India). This method should be explored for application in various fields including biodiversity, conservation biology, ecology, population studies, phylogeographic, etc. It is more a novel and a rapid method for species description and identification put forward based on the DNA sequences and it undoubtedly serves as a complementary approach for the existing traditional taxonomical practices. Although the conventional morphology-based method of species identification is available, it is on a slow track due to many reasons such as inaccessibility of important type material for comparison, unavailability of old literature, decreasing number of specialists and very importantly, negligible number of students entering in this field.

Conclusion

With around 6,000 species, this Nymphalidae is the largest family of butterflies. Many species, like the monarch butterfly, are very colorful. Butterflies in this family are called brush-foots because of their tiny forelegs. Their front two legs look more like brushes than feet and are not used for walking. Many species in this family have some brown or orange on their wings and veins on their forewings. Most species have long antennae with rounded clubs at the end. Most of the caterpillars in this family are colorful and covered with spines or hair. Traditionally the family *Nymphalidae* as now defined has been treated as a number of families, including the satyrs *(Satyridae)*, monarchs *(Danaidae)*, heliconians *(Heliconiidae)*, and snouts *(Libytheidae)*. More recent concepts of phylogenetic analysis and classification have resulted in these groups being treated as subfamilies of the *Nymphalidae*. By this revised definition, the *Nymphalidae* contains about 220 species in North America and 102 in Canada.The forelegs of nymphalids are reduced in size, usually in both sexes (not in *Libytheinae* females), and covered with long

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hairs, so as to resemble a brush. They are so small as to be practically useless; nymphalids perch and walk using four legs only, with the front pair held up under the "face".

Unlike the other families, nymphalids vary greatly in appearance in larval, pupal, and adult stages. Adults range from small to large, with most being of medium size. In North America, the most common colour is orange brown but there are many exceptions to this. Some species are powerful fliers (*Polygonia*) or migrants (*Vanessa*), while others (*Euphydryas*) are very weak fliers living in small, highly localized colonies.

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