

# MOTORCYCLES

## Overall Trends

### 1 Introduction

In 2021, motorcycle production in Japan increased by 33.5% from 2020 to 647,000 units, reversing the declines caused by the effects of the COVID-19 pandemic that started in 2019. Exports also increased by 40.1% to 437,000 units and shipments inside Japan rose by 15.3% to 379,000 units.

### 2 Production and Demand Trends

#### 2.1. Production

As shown in Fig. 1, the number of motorcycles produced in Japan in 2021 increased by 33.5% from 2020 to a total of 647,000 units. Exports increased by 40.1% to 437,000 units, while shipments inside Japan rose 15.3% to 379,000 units.

#### 2.2. Demand in Japan

Figure 2 shows motorcycle demand in Japan based on engine displacement. Despite lower demand for mini-sized motorcycles, which decreased by 0.5% compared to 2020, demand for all other categories of motorcycles increased, causing overall demand to rise by 15.3% to 379,000 units.

#### (1) 50 cm<sup>3</sup> or Less Displacement Motorcycles (Class 1 Motor-Driven Cycles)

In 2021 the demand for this class of motorcycles increased by 4.3% from the previous year to 128,000 units.

#### (2) 51 to 125 cm<sup>3</sup> Displacement Motorcycles (Class 2 Motor-Driven Cycles)

In 2021 the demand for this class of motorcycles increased by 23.5% from the previous year to 126,000 units.

#### (3) 126 to 250 cm<sup>3</sup> Displacement Motorcycles (Mini-Sized Motorcycles)

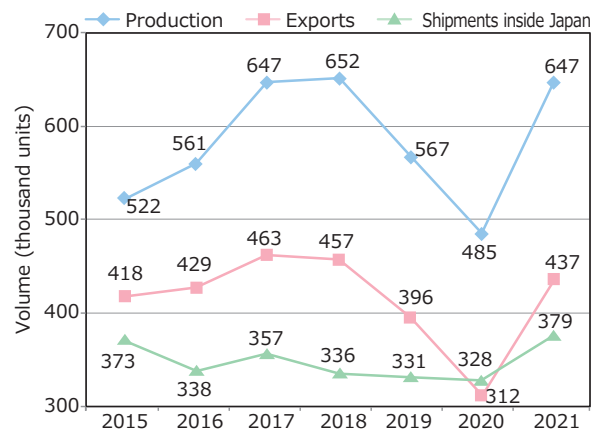
In 2021 the demand for this class of motorcycles decreased by 0.5% from the previous year to 67,000 vehicles,

#### (4) 251 cm<sup>3</sup> or Higher Displacement Motorcycles (Small-Sized Motorcycles)

In 2021 the demand for this class of motorcycles increased by 58.4% from the previous year to 58,000 vehicles.

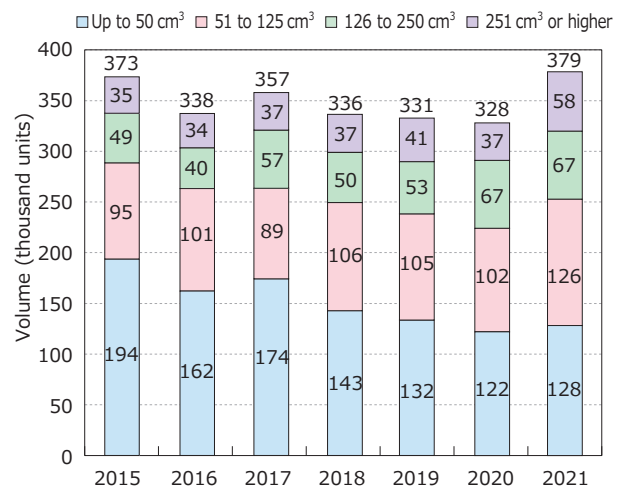
#### 2.3. Exports

In 2021, exports to all regions rose due to higher mo-



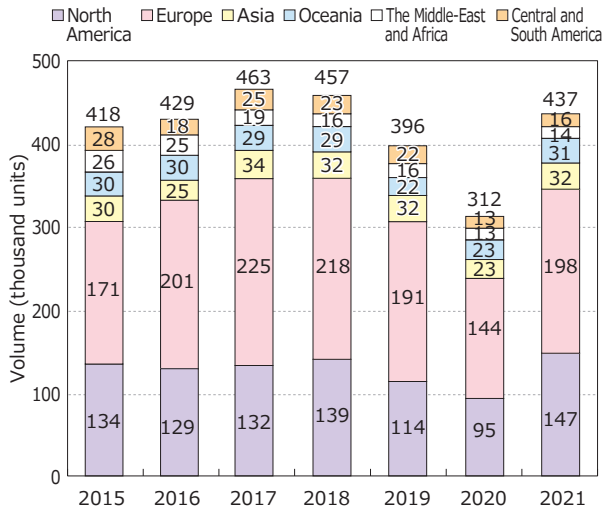
\* Source: Japan Automobile Manufacturers Association database

Fig. 1 Trends for Production, Exports, and Shipments inside Japan



\* Source: Japan Automobile Manufacturers Association database

Fig. 2 Shipments inside Japan based on Engine Displacement



\* Source: Japan Automobile Manufacturers Association database

Fig. 3 Shipments per Market

motorcycle demand for personal transportation and leisure during the global COVID-19 pandemic, increasing by 40.1% to 437,000 units (Fig. 3).

**(1) North America**

Motorcycle exports to North America in 2021 increased by 54.4% from the previous year to 147,000 units.

**(2) Europe**

Motorcycle exports to Europe in 2021 increased by 37.1% from the previous year to 198,000 units.

**(3) Asia**

Motorcycle exports to Asia in 2021 increased by 40.3% from the previous year to 32,000 units.

**(4) Oceania**

Motorcycle exports to Oceania in 2021 increased by 31.1% from the previous year to 31,000 units.

Table 1 Details of Main New Motorcycles Launched in 2021

Month of launch	New	Rede-signed	Manufacturer	Name of model	Characteristics
January		○	Kawasaki	Z900	Liquid-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
			Suzuki	Address V50	Forced air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
			Suzuki	Katana	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
			Yamaha	YZF-R3 ABS	Liquid-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
			Yamaha	YZF-R25 ABS	Liquid-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
			Suzuki	GSX-R125 ABS	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
			Suzuki	GSX-S125 ABS	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
			Honda	PCX160	Liquid-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
			Honda	PCX	Liquid-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
			Honda	PCX e:HEV	Liquid-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
			Honda	CB650 R	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
			Honda	CBR650 R	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
			Suzuki	SV650	Liquid-cooled/4 -stroke/V2 /DOHC/4 -valve/FI
			Suzuki	SV650 X	Liquid-cooled/4 -stroke/V2 /DOHC/4 -valve/FI
			Yamaha	YZF-R1 Race Base model	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
			Yamaha	YZF-R6 Race Base model	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
February	○		Kawasaki	Meguro K3	Air-cooled/4 -stroke/parallel 2 -cylinder/SOHC/4 -valve/FI
			Kawasaki	Ninja 650	Liquid-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
			Kawasaki	Ninja 650 KRT Edition	Liquid-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
			Yamaha	Axis Z	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
			Suzuki	GSX-S750 ABS	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
			Honda	NC750 X	Liquid-cooled/4 -stroke/inline 2 -cylinder/OHC/4 -valve/FI
			Honda	NC750 X Dual Clutch Transmission	Liquid-cooled/4 -stroke/inline 2 -cylinder/OHC/4 -valve/FI
			Honda	Gold Wing	Liquid-cooled/4 -stroke/horizontally opposed 6 -cylinder/OHC (uni-cam)/FI
			Honda	Gold Wing Tour	Liquid-cooled/4 -stroke/horizontally opposed 6 -cylinder/OHC (uni-cam)/FI
			Honda	Dio 110	Air-cooled/4 -stroke/single-cylinder/OHC/FI
March	○		Yamaha	Jog	Liquid-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
			Yamaha	Jog Deluxe	Liquid-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
			Yamaha	Vino	Liquid-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
			Honda	Rebel 1100 Dual Clutch Transmission	Liquid-cooled/4 -stroke/inline 2 -cylinder/OHC/4 -valve/FI
			Suzuki	V-Strom 650 ABS	Liquid-cooled/4 -stroke/V2 /DOHC/4 -valve/FI
			Suzuki	V-Strom 650 XT ABS	Liquid-cooled/4 -stroke/V2 /DOHC/4 -valve/FI
			Yamaha	SR400 Final Edition	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
			Suzuki	V-Strom 1050 ABS	Liquid-cooled/4 -stroke/V2 /DOHC/4 -valve/FI
			Suzuki	V-Strom 1050 XT ABS	Liquid-cooled/4 -stroke/V2 /DOHC/4 -valve/FI
			Suzuki	Burgman 200 ABS	Liquid-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
			Honda	CB1300 Super Four	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
			Honda	CB1300 Super Bold'or SP	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
			Honda	CB1300 Super Four	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
Honda	CB1300 Super Bold'or SP	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI			
Suzuki	Gixxer 150	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI			

**Table 1** Details of Main New Motorcycles Launched in 2021 (Cont.)

Month of launch	New	Rede-signed	Manufacturer	Name of model	Characteristics
March		○	Honda	CB1000 R	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
			Honda	X-ADV	Liquid-cooled/4 -stroke/inline 2 -cylinder/OHC/4 -valve/FI
			Honda	Forza	Liquid-cooled/4 -stroke/single-cylinder/OHC/2 -valve/FI
			Honda	Grom	Air-cooled/4 -stroke/single-cylinder/OHC/FI
			Honda	Gyro e:	AC synchronous motor
April	○	○	Kawasaki	Z H2 SE	Liquid-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
			Suzuki	Hayabusa	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
			Yamaha	Tricity 125	Liquid-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
			Yamaha	Tricity 125 ABS	Liquid-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
			Suzuki	Gixxer SF250	Oil-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
			Honda	CB125 R	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
			Honda	GB350	Air-cooled/4 -stroke/single-cylinder/OHC/FI
			Yamaha	MT-03 ABS	Liquid-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
			Yamaha	MT-25 ABS	Liquid-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
Yamaha	TMAX560 Tech Max ABS	Liquid-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI			
May	○	○	Honda	Rebel 1100	Liquid-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
			Suzuki	Gixxer 250	Oil-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
			Kawasaki	Ninja ZX-10 R	Liquid-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
June		○	Yamaha	Bolt R-Spec ABS	Air-cooled/4 -stroke/V2 /SOHC/4 -valve/FI
			Kawasaki	Ninja ZX-10 RR	Liquid-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
			Yamaha	NMAX ABS	Liquid-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
July	○	○	Suzuki	Burgman 400 ABS	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
			Honda	GB350 S	Air-cooled/4 -stroke/single-cylinder/OHC/FI
			Kawasaki	Versys 1000 SE	Liquid-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
			Honda	Cross Cub 110	Air-cooled/4 -stroke/single-cylinder/OHC/FI
			Honda	ADV150	Liquid-cooled/4 -stroke/single-cylinder/OHC/FI
			Yamaha	XMAX ABS	Liquid-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
			Yamaha	MT-07 ABS	Liquid-cooled/4 -stroke/inline 2 -cylinder/DOHC/4 -valve/FI
			Yamaha	Tracer 9 GT ABS	Liquid-cooled/4 -stroke/inline 3 -cylinder/DOHC/4 -valve/FI
			Yamaha	MT-09 SP ABS	Liquid-cooled/4 -stroke/inline 3 -cylinder/DOHC/4 -valve/FI
			Suzuki	GSX-R1000 R ABS	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
August		○	Suzuki	GSX-S1000	Liquid-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
			Suzuki	Address 110	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
			Yamaha	MT-09 ABS	Liquid-cooled/4 -stroke/inline 3 -cylinder/DOHC/4 -valve/FI
September		○	Kawasaki	Z900 RS	Liquid-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
			Kawasaki	Z900 RS Cafe	Liquid-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
			Kawasaki	Z250	Liquid-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
			Kawasaki	Ninja 400	Liquid-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
			Kawasaki	Ninja 400 KRT Edition	Liquid-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
			Kawasaki	Ninja ZX-25 R	Liquid-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
			Kawasaki	Ninja ZX-25 R SE	Liquid-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
			Kawasaki	Ninja ZX-25 R SE KRT Edition	Liquid-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
			Honda	CRF110 F	Air-cooled/4 -stroke/single-cylinder/OHC/FI
			Honda	CRF50 F	Air-cooled/4 -stroke/single-cylinder/OHC
			Kawasaki	KX450	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
			Kawasaki	KX250	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
			Kawasaki	KX450 X	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
			Kawasaki	KX250 X	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
			Kawasaki	KX112	Liquid-cooled/2 -stroke/single-cylinder/piston reed valve
			Kawasaki	KX85	Liquid-cooled/2 -stroke/single-cylinder/piston reed valve
			Kawasaki	KX85 L	Liquid-cooled/2 -stroke/single-cylinder/piston reed valve
			Kawasaki	KX65	Liquid-cooled/2 -stroke/single-cylinder/piston reed valve
			Suzuki	RM-Z450	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
			Suzuki	RM-Z250	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
			Kawasaki	Z400	Liquid-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
Honda	Super Cub C125	Air-cooled/4 -stroke/single-cylinder/OHC/FI			
Honda	Monkey 125	Air-cooled/4 -stroke/single-cylinder/OHC/FI			
October		○	Kawasaki	KLX110 R L	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
			Kawasaki	Ninja 400	Liquid-cooled/4 -stroke/2 -cylinder/DOHC/4 -valve/FI
			Honda	CRF250 R	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
			Honda	CRF250 RX	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
			Honda	CRF150 R	Liquid-cooled/4 -stroke/single-cylinder/OHC (uni-cam)/4 -valve
			Honda	CRF150 R II	Liquid-cooled/4 -stroke/single-cylinder/OHC (uni-cam)/4 -valve
			Honda	CRF125 F	Air-cooled/4 -stroke/single-cylinder/OHC/FI
			Yamaha	YZ450 F	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
			Yamaha	YZ250 F	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI

**Table 1** Details of Main New Motorcycles Launched in 2021 (Cont.)

Month of launch	New	Rede-signed	Manufacturer	Name of model	Characteristics
October	○	○	Yamaha	YZ250	Liquid-cooled/2 -stroke/single-cylinder
		○	Yamaha	YZ125	Liquid-cooled/2 -stroke/single-cylinder
		○	Yamaha	YZ85	Liquid-cooled/2 -stroke/single-cylinder
		○	Yamaha	YZ85 LW	Liquid-cooled/2 -stroke/single-cylinder
		○	Yamaha	YZ65	Liquid-cooled/2 -stroke/single-cylinder
		○	Yamaha	YZ450 FX	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Yamaha	YZ250 FX	Liquid-cooled/4 -stroke/single-cylinder/DOHC/4 -valve/FI
		○	Yamaha	YZ250 X	Liquid-cooled/2 -stroke/single-cylinder
		○	Yamaha	YZ125 X	Liquid-cooled/2 -stroke/single-cylinder
		○	Yamaha	PW50	Air-cooled/2 -stroke/single-cylinder
		○	Kawasaki	Meguro K3	Air-cooled/4 -stroke/parallel 2 -cylinder/SOHC/4 -valve/FI
		○	Honda	Gyro Canopy e:	AC synchronous motor
November	○	○	Honda	CB1100 EX Final Edition	Air-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Honda	CB1100 RS Final Edition	Air-cooled/4 -stroke/inline 4 -cylinder/DOHC/4 -valve/FI
		○	Honda	Tact	Liquid-cooled/4 -stroke/single-cylinder/OHC/FI
		○	Honda	Tact Basic	Liquid-cooled/4 -stroke/single-cylinder/OHC/FI
		○	Kawasaki	Z900	Liquid-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
December	○	○	Kawasaki	KLX230 R	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Kawasaki	KLX230 R S	Air-cooled/4 -stroke/single-cylinder/SOHC/2 -valve/FI
		○	Honda	CRF450 R	Liquid-cooled/4 -stroke/single-cylinder/OHC (uni-cam)/4 -valve/FI
		○	Honda	CRF450 RX	Liquid-cooled/4 -stroke/single-cylinder/OHC (uni-cam)/4 -valve/FI
		○	Kawasaki	W800	Air-cooled/4 -stroke/parallel 2 -cylinder/SOHC/4 -valve/FI
		○	Kawasaki	W800 Street	Air-cooled/4 -stroke/parallel 2 -cylinder/SOHC/4 -valve/FI
		○	Kawasaki	W800 Cafe	Air-cooled/4 -stroke/parallel 2 -cylinder/SOHC/4 -valve/FI
		○	Kawasaki	Z650	Liquid-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Z H2	Liquid-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Z H2 SE	Liquid-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Ninja 650	Liquid-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
		○	Kawasaki	Ninja 650 KRT Edition	Liquid-cooled/4 -stroke/parallel 2 -cylinder/DOHC/4 -valve/FI
		○	Yamaha	Cygnus Gryphus	Liquid-cooled/4 -stroke/single-cylinder/SOHC/4 -valve/FI
○	Kawasaki	Ninja ZX-10 R	Liquid-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI		
○	Kawasaki	Ninja ZX-10 RR	Liquid-cooled/4 -stroke/parallel 4 -cylinder/DOHC/4 -valve/FI		

### (5) The Middle-East and Africa

Motorcycle exports to the Middle East and Africa increased by 2.1% from the previous year to 14,000 units.

### (6) Central and South America

Motorcycle exports to Central and South America in 2021 increased by 23.5% from the previous year to 16,000 units.

## 3 Product and Technological Trends —

### 3.1. Product Trends

Table 1 lists some of the representative motorcycle models launched in Japan in 2021.

Although virtually no class 1 motor-driven cycles debuted in 2021 other than the Honda Gyro e and Gyro Canopy e, which are electric motorcycles for business purposes, the class 2 motor-driven cycle segment saw the launch of the new Yamaha Cygnus Gryphus as well as minor redesigns for models such as the Honda PCX, CB125R, and Monkey 125, the Yamaha Axis Z, as well as the Suzuki Address 110 and GSX-R125 ABS.

Again, although no new mini-sized motorcycles debuted in 2021, partially redesigned versions of models

such as the Honda PCX160, ADV150, and Forza, the Yamaha YZF-R25 ABS and MT-25 ABS, the Suzuki Burgman 200 ABS and Gixxer 250, as well as the Kawasaki Ninja ZX-25R and Z250 were launched.

In the small-sized motorcycle class, Honda launched the Rebel 1100 and GB350, models with classic and simple exterior designs, and Kawasaki debuted the Meguro K3. This year also saw minor redesigns for models such as the Honda CB1100 EX Final Edition, the Yamaha SR400 Final Edition, the Suzuki SV650X, and the Kawasaki W800.

Other new models included the Kawasaki Z H2 SE featuring an electronically controlled suspension. There were also minor redesigns for models such as the Honda X-ADV featuring enhanced electronic controls, Yamaha Tracer 9 GT ABS, and Suzuki Hayabusa.

### 3.2. Technological Trends

Electrification is an important means of reducing carbon dioxide emissions. This year saw the debut of two new electric motorcycles from Honda: the Gyro e and Gyro Canopy e in the class 1 motor-driven cycle segment. The scale of electrification is likely to expand in





**Table 1** Specifications of New Engines in 2021

Manufacturer	Name of model	Engine type	Displacement (cm <sup>3</sup> )	Bore (mm)	Stroke (mm)	Max. power (kW/rpm)	Max. torque (N·m/rpm)
Honda	Rebel 1100/1100 DCT GB350/350S	Liquid-cooled/4-stroke/inline 2-cylinder/SOHC/4-valve	1,084	92.0	81.5	64 /7,000	98 /4,750
		Air-cooled/4-stroke/single-cylinder/SOHC/2-valve	348	70.0	90.5	15 /5,500	29 /3,000
Yamaha	MT-09 SP ABS YZF-R7	Liquid-cooled/4-stroke/inline 3-cylinder/DOHC/4-valve	888	78.0	62.0	88 /10,000	93 /7,000
		Liquid-cooled/4-stroke/inline 2-cylinder/DOHC/4-valve	688	80.0	68.6	54 /8,750	67 /6,500
Suzuki	Hayabusa GSX-S1000	Liquid-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve	1,339	81.0	65.0	138 /9,700	149 /7,000
		Liquid-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve	998	73.4	59.0	110 /11,000	105 /9,250
Kawasaki	Ninja ZX-10RR Bimota Tesi H2	Liquid-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve	998	76.0	55.0	150 /14,000	112 /11,700
		Liquid-cooled/4-stroke/inline 4-cylinder/DOHC/4-valve	998	76.0	55.0	170 /11,500	141 /11,000

**Fig. 1** Rebel 1100**Fig. 2** GB350**Fig. 3** MT-09 SP**Fig. 4** YZF-R7**Fig. 5** Hayabusa**Fig. 6** GSX-S1000

ciency compared to the previous Twin Swirl Combustion Chambers (TSCCs). This engine also features a newly developed 43 mm electronic throttle body. Valve overlap is reduced and both performance and controllability are increased in low- and mid-rpm ranges using a connecting pipe between exhaust pipes #1 and #4 as well as #2 and #3. Strength and rigidity are optimized using lightweight pistons and connecting rods. The crankshaft modifies the oil distribution in the engine by adopting a different oil passage, helping to improve the lubrication of each component. The Hayabusa also adopts a wide range of newly designed parts, including the transmission and cam chain tensioner. Figure 5 shows the external appearance of this motorcycle.

#### (b) GSX-S1000

This model is equipped with a 998 cm<sup>3</sup> liquid-cooled, 4-stroke, inline 4-cylinder, DOHC, 4-valve engine featuring a modified cam profile and intake/exhaust system. It

also adopts an electronic throttle and throttle-by-wire system, which increase maximum power by 1 kW to 110 kW. The GSX-S1000 is also equipped with the Bi-directional Quick Shift System that allows the rider to change gears without operating the clutch or throttle. The Suzuki Clutch Assist System (SCAS) was added to the slipper function on the previous model to make clutch operations easier. Figure 6 shows the external appearance of this motorcycle.

#### (4) Kawasaki Motors Corporation

##### (a) Ninja ZX-10RR

This model is equipped with a 998 cm<sup>3</sup> liquid-cooled, 4-stroke, inline 4-cylinder, DOHC, 4-valve engine featuring a new liquid-cooled oil cooler in addition to titanium connecting rods. The weight of each of the two ring pistons used on the specially designed camshaft was reduced by 30 g. Although maximum power remains unchanged, the rev limit was raised by 400 rpm to 14,700



Fig. 7 Ninja ZX-10RR



Fig. 8 Bimota Tesi H2



Fig. 9 M1000RR



Fig. 10 Multistrada V4



Fig. 11 Speed Triple 1200 RS



Fig. 12 890 Adventure

rpm. Figure 7 shows the external appearance of this motorcycle.

### (b) Bimota Tesi H2

This model is equipped with a 998 cm<sup>3</sup> liquid-cooled, 4-stroke, inline 4-cylinder, DOHC, 4-valve engine. This is Kawasaki's supercharged engine that generates maximum power of 170 kW. Although the Bimota Tesi H2 has attracted attention for its hub-center steering system, it also achieves superb maneuverability due to its dry weight of only 207 kg, 31 kg lighter than the Ninja H2. Figure 8 shows the external appearance of this motorcycle.

## 2 Technological Trends outside Japan

### (a) BMW M1000RR

This model is equipped with a 999 cm<sup>3</sup> liquid-cooled, 4-stroke, inline 4-cylinder, DOHC, 4-valve engine that generates 156 kW at 14,500 rpm, up from the 154.4 kW at 13,500 rpm of the S1000RR. The rev limit was also raised by 500 rpm to 15,100 rpm. This engine features major modifications such as 101 mm titanium connecting rods (length increased by 2 mm) and dual ring forged pistons with cross ribs that were each reduced in weight by 85 g and 12 g, respectively. The width of the rocker arms was also reduced by 1.5 mm to lower weight by 0.45 g. Figure 9 shows the external appearance of this motorcycle.

### (b) Ducati Multistrada V4

This model is equipped with a 1,158 cm<sup>3</sup> liquid-cooled, 4-stroke, V4, DOHC, 4-valve engine. The desmodromic valve system (forcible valve opening and closing system) that Ducati has traditionally adopted on the Multistrada V4 was replaced by spring-driven valves, which extend the valve clearance inspection and adjustment interval to 60,000 km. This engine is also equipped with a mechanism that deactivates the rear cylinders during idling. Optimum riding performance from low to high speeds was realized by changing the transmission ratios from the Panigale V4 that adopts the same engine (1st gear: 2.400 → 3.077, 6th gear: 1.227 → 1.080). Figure 10 shows the external appearance of this motorcycle.

### (c) Triumph Speed Triple 1200 RS

This model is equipped with a 1,160 cm<sup>3</sup> liquid-cooled, 4-stroke, inline 3-cylinder, DOHC, 4-valve engine. Displacement was increased from 1,050 cm<sup>3</sup>, the bore widened from 70 to 90 mm, and the stroke shortened from 71.4 to 60.8 mm. Compared to the Speed Triple 1050S, power was increased by 22.4 kW to 132.4 kW. In addition, the inertial mass of the crankshaft was reduced, helping to realize agile maneuverability. Figure 11 shows the external appearance of this motorcycle.

### (d) KTM 890 Adventure

This model is equipped with an 889 cm<sup>3</sup> liquid-cooled, 4-stroke, inline 2-cylinder, DOHC, 4-valve engine. Dis-







**Fig. 3** Honda ADV350



**Fig. 6** Kawasaki Z650RS



**Fig. 4** Aprilia SR GT



**Fig. 7** Yamaha XSR900



**Fig. 5** Honda GB350



**Fig. 8** Suzuki GSX-S1000

ing for a tough and free lifestyle. Two examples of this are the Ducati DesertX (Fig. 1) and the Norden 901 from Husqvarna Motorcycles (Fig. 2). The design of the DesertX is rooted in the rally raid race bikes that competed in events such as the Paris-Dakar Rally in the 1990s. In contrast, the Norden 901 retains the simple and modern image that is at the core of Husqvarna's design language. Both models have extremely interesting yet contrasting design approaches while still expressing a genuine off-road image.

A crossover category between adventure and easy riding models equipped with automatic transmissions is also enjoying significant expansion. In 2017, Honda took the initiative in this category with the X-ADV. An increasing number of models have entered the market since then, supported by the following wind of a global

boom in outdoor leisure activities, as typified by the Honda ADV350 (Fig. 3) and Aprilia SR GT (Fig. 4). The ADV350 features a further refined version of the modern and tough styling of the same series, whereas the SR GT has a more dynamic and sporty design.

## 2. 2. Neo-Retro and Neo-Classic Motorcycles

These are also popular categories that have expanded significantly in recent years. These models combine a retro or classical exterior design with modern internals or functions.

The styling is characterized by the adoption of new technologies, particularly in the lamp system or functional parts, and design elements are used to actively differentiate between models. The design expresses the heritage of models in these categories, which is advantageous for historical brands. Some of the stand out models in these categories in 2021 were as follows.

### (a) Honda GB350 (Fig. 5)

The GB350 has simple and harmonious styling based



Fig. 9 Yamaha YZF-R7



Fig. 10 BMW CE 04

on a traditional sleek silhouette. The excellent overall balance of the design and presentation of metallic components creates a superb sense of high-class refinement.

#### (b) Kawasaki Z650RS (Fig. 6)

Although based on flowing styling that pays homage to models from the 1970s, the design of the Z650RS has been rebalanced to reflect modern proportions, creating a casual image typical of a mid-size model.

#### (c) Yamaha XSR900 (Fig. 7)

The XSR900 combines a modern-flavored styling with a sporty silhouette resembling a racing machine of the 1980s with the fairings removed. Elements such as a tail lamp embedded in the rear end of the seat and mirrors mounted on both ends of the handlebars help to create a fresh and wild image akin to that of a custom model.

### 2.3. Standard and Sporty Motorcycles

This year also saw strong demand for these universal motorcycle categories. As a whole, despite weaker demand for pure performance models across the overall motorcycle market, ordinary riders seem to be prioritizing higher performance. Accompanying this trend, design plays a major role in differentiating between models, and manufacturers are adopting a wide range of techniques to stand out. Some typical models are described below.

#### (a) Suzuki GSX-S1000 (Fig. 8)

The organic image of the previous model has been completely updated to create sharp and robust styling. Design elements such as a compact front end due to ver-

tically stacked small dual LED headlights and winglets positioned at the radiator shroud make effective use of new technologies, resulting in a fresh image.

#### (b) Yamaha TXF-R7 (Fig. 9)

Inspired by Yamaha's MotoGP machines, the TXF-R7 has a racy design with extremely slim styling that takes advantage of the characteristics of the base model. In addition to performance, this is an example of design that also factors in rider-friendliness. Compact LED headlamps are located inside the front ducts to create a deliberately unobtrusive impression that combines both an attractive design and functionality.

### 2.4. Electrification and New Technologies

Motorcycle manufacturers are launching a wide variety of electric models with an eye on the future. The designs of these models also incorporate various new ideas. Compared to conventional internal combustion engine (ICE) models, electric motorcycles have simpler structures and more flexibility in terms of body layout. This enables major innovations in design. One example is the BMW CE 04 (Fig. 10). The CE 04 has a low and long horizontal silhouette that distinguishes it from conventional motorcycles and scooters. Each part of the body is covered by solid panels to create an appearance that evokes the coming future.

While adopting new technologies throughout, such as LED lamps, daytime running lamps (DRLs), aerodynamic devices, a full-color LCD meter cluster, and smart phone connectivity, this model has an advanced design and interface that is both keenly influenced by and makes use of these technologies. Advanced rider assistance systems (ARAS) were a major subject of motorcycle technologies in 2021. Although these technologies have been adopted relatively quickly by cars and other four-wheeled vehicles, it is more difficult to install large sensors on motorcycles and create cohesive designs. However, as these technologies help to further enhance safety and comfort, their adoption is likely to become mandatory in the future.

## 3 Future Trends

In addition to the adoption of various new technologies and measures to comply with increasingly stringent regulations, higher material prices and supply chain restrictions due to the effects of the COVID-19 pandemic are pushing up development and manufacturing costs. Reflecting these trends, the adoption of common plat-

forms is likely to accelerate in accordance with electrification and, combined with market entries from different industries, there is the concern that motorcycles will become more and more commodified. In what is regarded as a once-in-a century transformation of the industry, manufacturers are expected to, better than ever, predict the ever-changing needs of the market while enhancing perceived product value. Therefore, it is important for

design development to constantly follow customer needs with a close awareness of market trends and new technologies, and make every effort to create even greater new value.

#### References

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